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Educational Technology and Visual Literacy: the Effect of Using Doodling on Student Learning Performance

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EDUCATIONAL TECHNOLOGY AND VISUAL LITERACY: THE EFFECT OF USING DOODLING ON STUDENT LEARNING PERFORMANCE

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ABSTRACT

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Visual literacy is one of the facets of educational technology that has a significant role in the learning process. Meaningful doodling was a technique researched in this study as a form of visual literacy. The purpose of this study was to explore the effect of meaningful doodling on the learning process and how this affected student learning performance. A mixed method design was used, which included the use of surveys of students in two classes that used doodling and by interviewing three teachers who regularly used doodling as a learning tool. The results suggested students enjoyed doodling and meaningful doodling was helpful in many areas of learning performance. From the responses of both students and teachers, five themes were confirmed: enjoyment, memorization or recall, complex ideas, brainstorming, and the ability to visualize thinking. Although this study had some important results, using meaningful doodling as a learning technique is a new topic that needs to be researched in greater depth to understand the importance of doodling on the learning environment.

Keywords: cognitive, doodling, education technology, learning process, visual literacy, visual thinking

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CHAPTER I

INTRODUCTION

Seeing comes before words. (Berger, 1972, p. 7)

This research study was about incorporating a visual method known as doodling into educational practices to improve learning and cognition. Humans have long needed to communicate with each other to survive. Human experience has nearly always been shared through spoken language but to be able to speak to others not present, humans needed to communicate first with drawings and finally written language. Visuals are essential to share thoughts and keep information from being lost. An old proverb tells us a picture is worth 10,000 words (Knowles, 1997). In elementary school books, large, colorful images are used to explain the concepts of written language. We can note that as the reading level increases, the number of images in textbooks decreases and the number of words increases. Do more advanced readers need less images to understand new content? Educators have learned over time that the idea of connecting images with words to explore new knowledge and build on existing knowledge is more impactful because the imaging process in our minds works faster than understanding text by itself. Using visual context with words gives us a clear picture about what is going on (Baddeley, 1992; Lohr, 2008; Mayer, 2009). For instance, a story or travel brochure describing Hawaii is never like seeing real images in Hawaii. Visuals are much more powerful in conveying multiple modes of meaning. This is parallel to learning. The more senses

learners involve in the learning process, the more intense the experience will be. This raises the scholarly question that with this assumption of increased intensity, is learning more effective using visuals? When visuals are added to text, learners not only have a more intense experience--the memory of the information lasts longer (Mayer & Moreno, 2003). To explain how this concept works, theorists have developed a concept of visual literacy. Visual literacy has become an important concept in education today (Bamford, 2003; Bleed, 2005; Finley, 2014; Lowe, 2000). It is important to educate teachers and students about visual literacy for enhancing the learning process and supporting the technology-rich environments in which students live their lives.

Doodling

Let's doodle! On hearing the word "doodle," the first thing that comes to mind is the scribbling or distraction doodling can provide. How does it fit in education? Doodling can help a teacher clarify visual literacy, which leads to visual thinking in the classroom in a simple way and helps students enhance their visual literacy by visualizing their thinking. Students can learn to make visuals that represent what they hear and learn in the classroom. It is important for learners to find ways that lead to better understanding; by using doodling, a learner uses both words and visuals to demonstrate knowledge of the subject. I hypothesized in this research that if we can incorporate the practice of doodling into the learning process as an enhancing tool for students, learning becomes more fun and interesting. And again, there is the scholarly question of whether doodling can help the learning process be more effective? Doodling could be another way to increase memory and reduce the learner's cognitive overload that can occur when facing huge amounts of information every day.

”I believe this is where real creativity takes place, where the most creative thinking and problem solving come to life” (Walker, 2012, p. 91). Doodling is more than mindless scribbling on a piece of paper--it is a creative way to visualize thinking, which leads to a deeper understanding of concepts (Brown, 2014). The other side of doodling goes beyond scribbling; it is purposeful. Using purposeful doodling is powerful; the bright side is it helps the learner achieve a higher level of remembering or recalling information and helps visualize concepts. Finding a new approach to thinking and learning requires educators to try new strategies instead of sticking with traditional ways of thinking.

Visuals can be in different shapes and styles including printed images, photographs, maps, table, charts, sketching, drawing, and doodling. These different facets or ways are used for making learning visual; how each of those facets can be used depends on the learners and his interest. In this study, the specific visualization tool I discuss is doodling. Specifically, I researched how doodling could help learners think deeply and visualize their thinking of complex concepts and ideas. Doodling is a strategy that can be introduced into the classroom setting to lead students to develop visual thinking and improve visual literacy.

In the 21st century, doodling can occur not only in a traditional way with pencil and paper, it can also be digital using an iPad, tablet, or laptop. This can give learners the chance to share their doodling with other students and vice versa. Doodling is personal. It is up to each person to discover how this strategy works.

Statement of the Problem

The purpose of this research was to discover whether or not using doodling techniques in the classroom would affect students' learning processes. The idea of integrating doodling in the learning process was not about providing learners with some doodling or letting the teacher perform some type of doodling in the classroom while presenting the concept. It was about getting learners to become involved in the learning process by having learners doodle during the class lesson. Using this method, students can visualize their thinking and present their thoughts in their own way. Educators can use many different forms of visual prompts during lectures. Classroom teachers want to know which methods work best. If teachers understand how the brain processes information using visuals, teachers can establish tools and strategies consistent with those processes. The reality of today's technological and visual world brings the need for integrating visual literacy into the education setting. Doodling is a strategy that integrates these concepts into learning. Today's learners are surrounded with smart technology including the Internet, iPhones, iPads, tablets, laptops, etc. These smart devices rely on imagery and are considered a visual medium (Bleed, 2005). In any educational setting, the main goal of instructors is to provide learners with a meaningful learning environment through which they learn new knowledge, i.e., the information provided should be significant and memorable (Lohr, 2008). With the amount of information and messages surrounding us every day, it is hard to remember what is necessary for a long enough period of time unless we find ways to reduce the cognitive load. Expressive imagery or "visualizing" is the most effective way to make information or messages attach to long-term memory and release the overwhelming cognitive load facing learners

(Cook, 2006; Lohr, 2008; Mayer & Moreno, 2003). The question for educators who are becoming more familiar with using this technology and want to integrate visual literacy into the curriculum remains--what are the best tools and strategies for students to improve their visual literacy as well as their ability to retain knowledge?

No teaching method is suitable for everyone. The doodling technique might not fit all individuals but it could maximize understanding for all types of learners. Why? Because researchers have found doodling is involved in all types of learning styles, which leads to more efficient, maximum learning (Brown, 2014; Pillars, 2016). To achieve a higher level of understanding, the teaching method should match with a student's learning style as much as possible. Although matching is difficult to achieve, we can maximize it as much as possible (Stokes, 2002). Using visual or verbal cues alone does not accomplish the task so the idea of doodling was the solution for this gap since three kinds of learners (visual, auditory, and kinesthetic) could be involved in this process.

Since many individuals are concerned they cannot draw, this concern was alleviated with doodling because students do not need to be skilled artists to have doodling as a strategy for learning in the classroom from an early age. Students' use of doodling from the beginning would help improve this habit because most visualization skills can be improved by practicing (Stokes, 2002).

Purpose of This Study

The purpose of this study was to explore doodling techniques by teachers and the importance of using them in the learning process as an academic visual experience. How does doodling influence the learning process of the participant in the classroom among different academic subjects? In this study, I investigated the link between doodling and

learning. I wanted to explore the reason behind integrating doodling in the learning process, what students' and teachers' perspectives were regarding the effect of doodling on learning, and what influence doodling had on the learning process. It was not only about the importance of just showing a particular visual or presenting a certain concept visually as in other studies (McKay, 1999; Mayer, 2009; Stokes, 2002). This research was about students becoming involved in the process of doodling to gain a better understanding of the material by visualizing the concept being presented in the classroom.

Context of the Study

To best understand this phenomenon, I conducted this study using a survey instrument for students and an interview of teachers currently using a process called educational visual note-taking--an academic phrase for doodling. This study took place in a K-12 setting in a school in the southeastern coastal region of the United States.

Since many studies have already verified the significance of incorporating visual literacy in education (Bamford, 2003; Lowe, 2000), my study focused on the essential need to add visuals to the learning process in different ways and to make the process "show and tell" instead of "show" only. I wanted educators in this research to encourage their students to get engaged in the visual thinking process by having them show their understanding on paper and reflect what they understood from the lecture. The reasoning behind this process was it would positively reflect on students' cognitive load memory.

By using survey and interview questions as instruments to answer my research questions, I explored the perspective of teachers who integrated doodling as a learning tool in the classroom. In addition, I wanted to understand the perspective of students who

had already used doodling as a tool to visualize their thinking, what concepts they used, and how this reflected on their learning achievement.

Since not many studies showed teachers or students had applied doodling to their learning processes, a huge gap in the literature still needs to be filled. The result of this study could not only show the importance of doodling in the educational setting but also show the significance of incorporating doodling in all aspects of education and confirm that doodling could be used effectively in more areas than art.

Rationale

It is important to adapt the concept of visual literacy in the educational setting. There are many reasons behind the need to include doodling in the learning process. Some studies (Aellig, Cassady, Francis, & Toops, 2009; Ainsworth, Prain, & Tytler, 2011; Andrade, 2010; Brown, 2014) have addressed the concept of doodling and how the use of this technique reflected positively on recalling information and understanding. The majority of studies were concerned with psychology and business. Visual language is considered a native language for everyone since doodling starts when children learn to handle a crayon or a pencil (Brown, 2014). As people age, this doodle language gets better, clearer, more visible, and makes more sense. What is needed is to focus more to enhance this skill through training. Most people have a false idea about visual language. People tend to think a creative sense and an ability to draw are necessary. Everyone has the ability to doodle--doodling is not the same as professional art (Brown, 2014). Studies showed a belief in integrating visualization with learning reflected positively on the cognitive process (Cook, 2006; Lohr, 2008; Mayer & Moreno, 2003). When there is unlimited information available, as there is using today's technology, we need new

learning strategies to help us recall, learn, and think (Beatty, 2013; Brown, 2014; Lohr, 2008).

For this study, I was more specific about doodling and discussed how the use of doodling influenced the learning process. As mentioned earlier, not many studies have been conducted in this area. Gaps still need to be filled in the literature; more studies are needed to discover the importance of using doodling in the learning process and how integrating these strategies in classrooms effectively would provide significant depth to visual literacy.

Research Questions

The following research questions guided this dissertation:

Q1 What do teachers and students perceive as the affordances and constraints of doodling as part of the learning process in a high school classroom?

- Q1a What are students' perspectives regarding how doodling helps them learn?
- Q1b What are teacher perspectives about the student use of doodling in the learning process?

Q2 How does doodling contribute to the development of students' cognitive processes?

- Q2a How does the use of meaningful doodling in the classroom enhance recalling content knowledge?
- Q2b How does the use of meaningful doodling improve student brainstorming and visualize thinking?
- Q2c How does the use of meaningful doodling improve understanding of complex concepts?
- Q2d Is there a difference in the use of meaningful doodling between recalling content knowledge, student brainstorming, visualization, and understanding of complex concepts?

Significance of the Study

In this study, I explored how teachers helped students learn to use doodling with more purpose to encourage deeper learning. One way to discover what is suitable and more comfortable for each individual is by encouraging the individual to try to doodle, especially if the learner is not confident when drawing. Creativity in presenting a subject in the classroom is required because of the amount of technology surrounding students every day. Teachers need tools that attract students' attention.

Teachers should enhance students' curiosity to make learning happen effectively. Although studies (McKay, 1999; Mayer, 2009; Stokes, 2002) showed the impact visuals had on education, information was lacking about the benefits of using different types of visual literacy such as doodling. Many teachers still hesitated to allow students to doodle during lectures because the teacher thought doodling distracted students. On the other hand, some teachers who allowed students to doodle during class did not feel attention was lost. The literature did not reflect which attitude was more correct.

In addition, no studies investigated teachers' or students' perspectives of the use of doodling as a learning tool to enhance the learning environment. No studies were found regarding how doodling could facilitate learning in an effective way. Doodling is a tool each learner can adapt in a unique way to relate it to the class subject.

In her book, Pillars (2016), a K-12 teacher, used visual note-taking while she explained concepts to her students. She found she learned more than her students did so she decided she needed to let her students become involved in this process. Instead of having students look at her draw some visuals, she let them enjoy their own process of visualizing the idea she was lecturing about to maximize their understanding. The

current study was similar to this process; I wanted to see how students became involved in the process to better understand the material.

Operational Definitions

Doodling. The word "doodle" brings to mind some scribble a person makes when he or she is not thinking. The online Merriam Webster dictionary's (2015) definition is "to draw something without thinking about what you are doing." The Oxford English Dictionary defines the word doodle as "an aimless scrawl made by a person while his mind is more or less otherwise applied" (Schott, 2011, p. 1133). However, I determined these kinds of definitions were not suitable for this study because doodling was seen here from a different perspective. In this research, doodling refers to a purposeful doodling that reflects positively on user performance in learning and content retention. Many people are interested in doodling and take doodling seriously as a thinking strategy. Brown (2014) defined doodling as follows: "to make spontaneous marks with your minds and bodies in order to support thinking; to use simple visual language to active the mind's, engage multiple learning modalities, and support creativity, problem solving, and innovation" (p. 222).

Education technology.

> The analysis of learning and performance problems, and the design, development, implementation, evaluation and management of instructional and non-instructional processes and resources intended to improve learning and performance in a variety of settings, particularly educational institutions and the workplace. (Reiser & Dempsey 2012, p. 5)

Learning style. Keefe (1979) defined learning styles as the "composite of characteristic cognitive, affective, and physiological factors that serve as relatively stable

indicators of how a learner perceives, interacts with, and responds to the learning environment" (p. 4). Stewart and Felicetti (1992) defined learning styles as those "educational conditions under which a student is most likely to learn" (p. 5). Although many types of learning styles have been identified, the learning styles used in this research consisted of visual, auditory, and kinesthetic learning.

Visual literacy.

> Visual literacy refers to a group of vision-competencies a human being can develop by seeing and at the same time having and integrating other sensory experiences. The development of these competencies is fundamental to normal human learning. When developed, visual competency enables visually literate people to discriminate and interpret the visible actions, objects, and symbols (natural or man-made) they encounter in their environment. Through the creative use of these competencies, they are able to communicate with others. Through the appreciative use of these competencies, they are able to comprehend and enjoy the masterworks of visual communication. (Debes, 1969, p. 27)

Visual thinking. Visual thinking can be defined as a specific teaching method or strategy that can be used to help students understand what they are seeing when they view art objects (Moorman, 2013). Using visual thinking is simply thinking in pictures (Walker, 2012).

Summary

Without images, thinking is impossible. (Stokes, 2002, p. 10)

Finding and trying new strategies to engage learners is something not easily undertaken. Nothing fits everyone because people learn best in different ways. Sometimes the difficulty is not because the concept is hard to understand; the difficulty lies in the way we explain the concept. It is not explained well enough to help the learner understand. The purpose of this study was to examine whether or not the doodling technique as a learning process would work for students and to see if a minimum benefit

from this technique would be reflected in the learning process. Without trying doodling or being given guidance as to how to use doodling as a learning tool, learners would not know how to use this approach positively in their learning process. My belief was with proper guidance, doodling could make a difference in how we see and understand the world around us and could prove to be beneficial for students who are becoming active learners.

CHAPTER II

LITERATURE REVIEW

In the education technology field, the interactional designer needs to work on different areas to create a healthy learning environment. Education technologists do not merely implement technology, they also create instruction that facilitates student learning. Designers should create a path for learners to enhance their learning and make the learning environment more effective, efficient, and applied (Lohr, 2008). Designers make choices about the best pedagogical processes as well as appropriate tools, experiences, and environments for appropriate teaching and learning. Sometimes the best strategy does not include digital tools. A goal of the learning process is to develop cognitive processes; however, learning should also be fun and motivating.

Visual literacy refers to the many ways we can use visual material to gain understanding (Thibault & Walbert, 2017). Visual literacy can come in different shapes and kinds, e.g., using images, photographs, drawing, or painting (Finley, 2014; Thibault & Walbert, 2017). This research attempted to add doodling as a resource to enhance the learning process. Doodling is a visual literacy form that started long ago on a cave wall and is still being used today for pleasure and for learning (Leaño, 2014). When students take notes using images on paper reflecting what they hear from teachers, they demonstrate an ability to visualize their thinking; when they try to read it again to recall their information, their ability to read those visuals confirms they are visually literate.

Although the practice of doodling has been used for many thousands of years, it is a new area of study as it pertains to teaching and learning practices. Limited research is available about doodling in educational contexts (Aellig et al., 2009; Andrade, 2010; Brown, 2014; Pillars, 2016). Some studies in psychology discussed the effect drawing could make in learning (Brooks, 2009; Hope, 2008; Jolley 2010; King, 2011). Although those studies incorporated participants with different ages, methods, and instruments than the current study, they were supportive of the idea of this dissertation--to study the utilization of pencil and paper or an electronic device to create a meaningful visual aid (doodling, drawing, visual note-taking, etc.) related to the learning concept (Brooks, 2009; Hope, 2008; Jolley 2010; King, 2011).

Visual literacy and its impact on the educational system is important. Integration of visual literacy began a long time ago (Debes, 1969; Felton, 2008; Stokes, 2002). Since doodling--the topic of this paper--is one form of visual literacy in education as a technique to enhance learning, I reviewed available studies in which researchers found positive and negative effects for using visuals (doodling, drawing, etc.) with regard to learning, memorization, and the recall of information. This study stemmed from findings from previously published research studies and investigated the level of importance doodling had on learning according to student and teacher perspectives.

History of Visual Images and Doodling

Humans continue to rely on images, which can be considered a universal language people use to understand and explain many concepts (Schlosser, 2010). Doodling has been around for more than 40,000 years. People started doodling on cave walls using rocks, wood, and other tools to create visuals that presented meaning for

them. These drawings were perhaps of animals they saw or something they were concerned about as they were left behind as a history for people through the ages (Leaño, 2014; Qutub, 2012).

Leonardo da Vinci did not know Latin or Greek so he drew his thoughts so others were able to understand him (Hanusiak, 2009; Stokes, 2002). He doodled extensively in his journals. Today, many of da Vinci's doodles create amazement among people who saw he had drawn the basics for futuristic inventions such as the helicopter (Hanusiak, 2009; Stokes, 2002).

The word "doodle" might come from the German word for "fool." During the American Revolution, the song "Yankee Doodle" was sung by the British to make fun of the American army because they were not as organized as the British army. This is thought to be the reason why this form of drawing was called "doodling" because it did not seem to indicate organized thinking (Leaño, 2014). However, in 1963, Stanislaw Ulam, a Polish mathematician, was doodling during an uninteresting lecture and from that doodle, he discovered a visual for prime numbers called the Ulam Spiral (Hanusiak, 2009; Qutub, 2012). Forms of doodling have become part of visual literacy in education.

History of Visual Literacy in Education

Throughout history, educators have realized that images are important to education and using pictures to explain concepts can help students learn lessons more thoroughly (Stokes, 2002). Even Greek philosophers such as Simonides and Aristotle understood the importance of using images to assist with educating students. After the invention of the printing press, it was more difficult to create images with printed text so

most written material did not contain images. Thus, it became standard that most books did not contain pictures (Stokes, 2002, p. 10).

Images as part of learning theory have their beginnings in the late 20th century. Throughout the 20th century, most communication of ideas was in written form using limited imagery. Images were mostly confined to glossy popular magazines and newspapers. Although literacy as a term was important throughout the 20th century, visual literacy was not considered a separate issue until the late 1960s when John Debes introduced the term (Felton, 2008). Debes worked for Eastman Kodak. He and a group of educators put together the first national convention about visual literacy (Felton, 2008).

With the introduction of the Internet, images have become much more important to the domain of interaction and visual thinking (Felton, 2008). When distance learning became an educational standard, visual literacy as a pedagogical construct exploded into the 21st century (Stokes, 2002). In the past 15 years, online sources such as EDUCAUSE and universities such as Cambridge have incorporated visual literacy into educational programs (Felton, 2008). Some colleges and universities now offer courses in visual literacy and some professors outside of media courses are requiring students to submit final projects in a visual format. It is possible visual literacy might someday be a requirement for graduation (Bleed, 2005).

According to Bleed (2005), visual literacy has reached a tipping point, which is when something distinctive becomes popular. Visual literacy, especially in higher education, has become possible because the ability to use visuals is supported by technology. Students in colleges and universities are now more able to use screen

language or visual literacy than many of their professors. This presents a move away from analytical thinking the Information Age of computers has given us and is becoming the "Concept Age" of being able to create using visual information (Bleed, 2005).

Multiple Definitions of Visual Literacy

According to Felton (2008), people involved in education need to be taught the specifics of visual literacy, which he defines as involving "the ability to understand, produce, and use culturally significant images, objects, and visible actions" (p. 60). Educators often use images but that does not mean they are "visually literate" according to this definition. Being visually literate points to educators taking an active part in designing curriculum and teaching with visual literacy (Thibault & Walbert, 2017). Moreover, Stokes (2002) stated visualization by itself is not effective unless we apply visual learning in an appropriate way that helps to increase the student's or learner's performance. Before adopting visual literacy in any curriculum or instruction, the designer or instructor should be aware of the role of visual literacy to make lessons more powerful and effective.

To fully understand visual literacy, it is important to focus on the definition of visual literacy to give the reader a more in-depth understanding of the concept. This section mentions some of the important definitions that clarify the meaning of visual literacy. Upon reading literature with visual literacy as a focus, I found most of the definitions belonging to visual literacy were put together by specific authors to make the definition fit their studies.

Several studies such as Brill, Kim, and Branch (2007) and Felton (2008) mentioned that John Debes was the first person to use the term "visual literacy" as part of

education. In 1969, John Debes first discussed the concept visual literacy in education; he was the co-founder of the International Visual Literacy Association and the definition of visual literacy first used by him was as follows:

> Visual Literacy refers to a group of vision-competencies a human being can develop by seeing and at the same time having and integrating other sensory experiences. The development of these competencies is fundamental to normal human learning. When developed, they enable a visually literate person to discriminate and interpret the visible actions, objects, symbols, natural or man-made, that he encounters in his environment. Through the creative use of these competencies, he is able to communicate with others. Through the appreciative use of these competencies, he is able to comprehend and enjoy the masterworks of visual communication. (Debes, 1969, p. 27)

Debes's (1969) definition was the foundation of all other definitions of visual literacy. As his definition was the first to initiate the concept of visual literacy, others researchers claimed Debes's definition was usable but not necessarily complete. Many of the declarations that have come after have attempted to improve upon and broaden this definition. For example, Brill et al. (2007) stated Debes's definition did not clearly define how visual literacy is used in people's daily lives. In addition, the Debes's definition did not cover elements of motivation and interest; the definition was more about sensory experiences than symbolic modality.

On the other hand, there are researchers who support Debes's (1969) definition. For example, even Brill et al. (2007) agreed, "Visual literacy is the ability to both accurately interpret and create messages that are transmitted through the sense of sight, with emphasis on using communication systems that do not rely primarily on traditional text based alphabetic or numeric codes" (pp. 49-50). This definition supported the elements Debes used but emphasized communication might be more common on the internet than in books.

Many other scholars developed other definitions as they saw visual literacy from their points of view. They found new parts or concepts they thought should be involved that had not been previously covered in definitions of visual literacy. Horton (1983) defined visual literacy as a form of visual thinking, learning, and expression. The main concept added was visual thinking, which was not mentioned in earlier definitions. This definition also stated that "visual literacy is the ability to understand and use images, including the ability to think, learn, and express oneself in terms of images" (Horton, 1983, p.99).

Baca and Braden (1990) discovered the earlier definition by Horton (1983) did not cover the design and creativity in the definition. Therefore, they added to the definition by including the following terms:" Visual literacy refers to the use of visuals for the purposes of communication, thinking, learning, constructing meaning, creative expression, [and] aesthetic enjoyment" (Baca & Braden, 1990, p. 48). Thus, Baca and Braden included visual thinking along with creativity and aesthetical elements in their definition.

The concept of merging visual thinking with creativity in Baca and Braden's (1990) definition of visual literacy, which when added to Horton's (1983) definition, made it more powerful and stronger. As Moeller, Cutler, Fiedler, and Weier (2013) stated, creativity and visual thinking are related to each other and lead to the perfection of performance in the learning environment. They pointed out visual thinking stimulates critical thinking and creativity for learners in a classroom, which emphasized the addition of creativity to Baca and Braden's (1990) definition of visual literacy. Thus, visual

literacy consists of two main elements--visual thinking and creativity, leading to a more comprehensive definition.

Robinson (1984) defined visual literacy in this way:

> Visual literacy is the ability to process the elements of and to interpret visual messages, the ability to understand and appreciate the content and purpose of any image, as well as its structural and aesthetic composition. A visually literate person can perceive, understand and interpret visual messages, and can actively analyze and evaluate the visual communications they observe. (p. 50)

This definition is very close to Debes's (1969) definition in terms of interpreting and understanding visual messages. However, Robinson's definition gathered Debes's concept along with other claims to become a more comprehensive definition (Brill et al., 2007).

Similar definitions have arisen to explain visual literacy. Wileman (1993) defined visual literacy as "the ability to 'read,' interpret, and understand information presented in pictorial or graphic images" (p. 114). The main takeaway idea from all of these previous definitions is the term "literacy," as defined in the dictionary, means the ability to learn; thus, the definition of "visual literacy" is also the ability to learn but by using images. This was central to all the definitions although the various definitions differed in how students would use images and what was included in that use of imagery.

Felton (2008) reinforced this understanding of what visual literacy meant by saying, "The capacity to manipulate and make meaning with images is a core component of visual literacy" (p. 61). It was concluded that visual literacy should be taught in schools and be part of the overall pedagogy. However, attempts to offer visual literacy as a subject matter is new in college level classes and currently is not known in K-12

curricula (Felton, 2008, p. 62). Felton suggested students need to understand the concept of visual literacy as a way of manipulating imagery--not simply looking at pictures.

Maria D Avgerinou, co-editor of the Journal of Visual Literacy, pointed out the concept of visual literacy interrelates across many fields, which is the reason for having many definitions of visual literacy. Because of the interrelation of visual literacy in many disciplines, scholars reshaped the definition of visual literacy based on their specialties (Avgerinou, 2012). The main reason behind having so many definitions of visual literacy is it is a broad and wide subject that also covers parts of other fields. It could be involved everywhere in any learning or working environment, i.e., business, cooking, industrial technology, etc. In each field, scholars have created a definition to make the term more suitable for his/her specific area. However, all those definitions are mainly rooted in Debes's (1969) definition. While each definition was different based on the scholars' background and the purpose of their study, those changes did not change the roots of Debes's definition. This was supported by Baca and Braden's (1990) study where the purpose was to identify the elements of visual literacy using a research technique known as the Delphi method--experts are consulted to explore a concept and agreements and disagreements are examined to build a holistic picture of that concept. Their results indicated 19 individual elements comprised the concept of visual literacy; these elements included Debes's definition in addition to some concepts not covered by Debes's definition (Baca & Braden, 1990).

Educational Technology and Visual Literacy

Visual literacy can be a vital part in the area of education technology. Since the word visual is usually only related to art, it is not easy to appreciate how visual literacy

fits in the field of education technology. It was not obvious in any research or articles; rather it was implicit, requiring the reader to see between the lines to understand how visual literacy fits in the field of education technology. The goal was to make learning more organized and structured, which makes learning more effective, efficient, and appealing in the end. Educational technology helps to create a meaningful learning environment.

The definition of educational technology has been modified over time as technology has changed and developed. In the beginning in both business and education, the definition of education technology was mixed up with the meaning of the media used to present the instruction. What was meant by media was the visual material incorporated into the instruction such as images, films, slides, etc. (Reiser & Dempsey, 2012). The first definition considered for education technology was reported as "the enrichment of education through the 'seeing experience' [using] . . . flat pictures, models, exhibit, chart, map, graphs, stereographs, stereopticon slides and motion pictures" (Reiser & Dempsey, 2012, p. 3). This definition provided the first link between visual literacy and education technology where they were (and still are) connected by the significance of using images or visualization in general to create the needed instruction.

After many years, the definition of education technology took on a larger scope. Education technology had previously been defined as media and visual literacy. A current definition of education technology still contains media and visual literacy but the definition has grown to include much more. The definition commonly used now considers education technology as a process not simply defined by the material used such as film or media; it is a process the instructional designer goes through to create

meaningful learning instruction. Reiser and Dempsey (2012) defined educational technology as follows:

> The analysis of learning and performance problems, and the design, development, implementation, evaluation and management of instructional and non-instructional processes and resources intended to improve learning and performance in a variety of settings, particularly educational institutions and the workplace. (p. 5)

In this definition, visual literacy was not the main core as it was earlier but it could still be involved under each process mentioned in the definition. For example, under either the design or development phases, visual literacy could be involved. The instructional designer needs to enhance the strategies by adding visuals in designing the instruction or career learning aid. Hence, from the definition of education technology, visual literacy obviously fits into the field of education technology.

Livingstone (2004) suggested that as visualization is such an integral part of the technology, a new form of literacy is evolving but there is a question as to whether the labels "new" and "literacy" even apply to what is happening in education technology. Questions debated whether or not computer or media literacy is a new form among many forms of literacy educators and students need to learn or if it is a continuation of what is already meant by the term "literacy." This includes how visualization is implemented using technology. There are questions as to how the new literacies relate to the traditional forms of literacy of reading and writing. Livingstone argued a need for a framework that includes a new idea of the use of technology instead of trying to replace older technology in the same way. For example, visual literacy could be tied to media literacy as well as being tied to educational technology. For instance, simply because the television was invented, people did not stop listening to radio and when computers were

available in most homes, people did not stop watching television. Rather, new ways of using the newer technology emerged. Livingstone also discussed the many definitions of literacy that have caused confusion for educators and researchers. She stated, "In a key conference a decade ago, a clear, concise and widely adopted definition emerged: media literacy--indeed literacy more generally--is the ability to access, analyze, evaluate and create messages in a variety of forms" (p. 3). This definition was similar to the Reiser and Dempsey (2012) definition explored earlier. The difference in the article presented by Livingstone was she explained each process in the definition so it was clear what was meant by accessing, analyzing, evaluating, and creating messages. With this additional clarity, understanding visual literacy as it pertained to education technology was to understand the processes educators and students need to go through to be considered literate. An important difference in understanding the possible change in the definition of literacy was literacy has always meant how the individual learner becomes skilled or "literate." As technology becomes a more important part of education, literacy is changing. According to Livingstone, technology requires a more thorough understanding that involves culture, cognition, power, and education, all of which are included in the newer definition of media literacy. In this case, visual literacy is only one component of a larger definition.

Jones and Flannigan (2006) also suggested visual literacy as it applies to education technology has a new definition. Part of this newer definition concerns who is using the technology. The authors suggested children born in the digital age grow up using the technology and absorbing the literacy in the same way babies learn language. At the same time, older people sometimes struggle learning the new processes necessary

to become literate and might not become fully literate as a result. "A common scenario today is a classroom filled with digitally-literate students, being led by linear-thinking, technologically stymied, instructors" (Jones & Flannigan, 2006, p. 4).

Education technology is not just about technology tools. Instead, it is about the implicit way the instructional designer uses technology to design the curriculum. The term "visual" has been repeated frequently in the field of education technology. Usually, what is meant by "visual" and "text" is to assure visual literacy is a significant component in the field of education technology. As Mayer (2009) pointed out, using visual literacy in the learning process can improve learning effectiveness. The author demonstrated this idea by giving learners lessons--one group with words only and the other with words combined with visuals. Mayer concluded the group who had lessons that included visuals performed much better than the other group who had lessons with words only. Hence, lessons with visuals and words combined could create better understanding, which led learners to memorize the lessons. This meant the new experience was memorized faster in long-term memory (Mayer, 2009).

McKay (1999) studied the differences between using text only and text plus visuals for learning effectiveness. He separated groups of students by their levels of learning between novice and more experienced learners. His results demonstrated both groups had higher scores using images and text than with text only; novice learners showed the greatest improvement. Learning and human performance are critical to the field of education technology and that includes the idea of visual literacy (Stokes, 2002). To increase learning and performance, educators and designers need to include or create visuals or graphics to enhance that performance (Stokes, 2002).

Theory Linked with Visual Literacy

No specific theories help explain visual literacy but there is a theory involving visual literacy that shows how humans process information either verbally or visually. Cognitive load theory explains the importance of managing the load of information on working memory (Harasim, 2012). Learners might be confused and overwhelmed with teachers providing too much information given too quickly. Learners might also be confused by teachers not giving enough information because insufficient information is available to explain ideas completely.

Efficient learning environments are created by applying this theory to instructional design. If the amount of information, or the cognitive load, is too much for the learner, the information will be not effective and the learning environment will be negatively affected. On the other hand, if the cognitive load is too small, the learning environment will not be effective either. The role of the instructional designer is to create just the right amount of load knowledge in a way that makes it more effective for learners. The important part of cognitive load theory in determining effectiveness is how well information is able to move from the working memory to long-term memory (Harasim, 2012).

Cognitive load theory is also important in discussing visual literacy. Cognitive load theory, dual coding theory, and multi-media learning theory are all important theories instructional designers and teachers use to link learning with visual literacy to help explain how the learner can develop visually literate thinking skills (Beatty, 2013). Therefore, it is necessary to discuss how each of these theories fits with visual literacy, particularly in the case of doodling.

Three specific cognitive theories work best when explaining what happens when learners are able to combine visualization with verbal information: cognitive load theory, dual coding theory, and cognitive theory of multimedia learning principle. It is difficult to examine each theory separately because they often correlate with and depend on each other.

Cognitive Load Theory

Cognitive load theory (CLT) is used to help explain how some basic cognitive processes work, especially human working memory. Working memory includes long-term memory or the central executive (Baddeley, 1992; Sweller & Chandler, 1994). When researchers studied how the human mind worked to gather and store information, they realized the working memory is not able to learn and manage multiple ideas simultaneously. Learners need to practice using and understanding complex ideas by consciously merging simpler ideas (Sweller, 1994; Sweller & Chandler, 1994; Van Merrienboer & Sweller, 2005). According to Sweller (1994), a schema is "a cognitive construct that organizes the elements of information according to the manner with which they will be dealt" (p. 296). Schemata work like file folders in a computer file. A schema can include complex information, much like a file folder can hold many documents, so a schema is considered a single element within the central executive. When a learner needs to access specific information, it can be a matter of selecting the right file folder or schema. On the other hand, when a learner is confronted with trying to learn more information, working memory is only able to manage a few details at a time. As the learner adds new knowledge to existing schemata, that knowledge moves into the long-term memory. Once knowledge is stored in long-term memory, much of it actually

becomes automatic if it is repeated often enough. According to CLT, once the schemata arranges the new knowledge, especially if it becomes automatic, the learner is able to process the complex information and that knowledge moves into long-term memory. At that point, there is no known limit as to how much knowledge can be filed away (Van Merrienboer & Sweller, 2005).

Cognitive load theory suggests the amount of information presented can help the learner understand complex ideas and add them to existing schemata, which in turn can be repeated and added to existing knowledge to build long-term memory. Educators have long known the benefits of repetition for storing information in long-term memory. Cognitive load theory suggests how repeating information moves it to long-term memory because repetition builds on an existing cognitive load and keeps out any non-essential information that would overload the schemata being built (Van Merrienboer & Sweller, 2005). Educators utilizing this theory became aware that if knowledge is presented in ways the learner can use to build on existing knowledge, then the effect of cognitive overload is less likely to happen.

Cognitive Overload

If, as Van Merrienboer and Sweller (2005) suggested, long-term memory has no known limits, there are still limits to how much information can be sorted and understood before it is managed, filed away, and stored in long-term memory. Mayer and Moreno (2003) discussed the idea that cognitive overload interferes with the managing of new knowledge when too much information is introduced, when ideas are too complex, or simply because ideas are so new the learner has no foundation on which to build. The learner needs to be able to process new information. Sweller and Chandler (1994)

suggested cognitive load is especially connected to how new information is related to existing knowledge. If knowledge is presented in ways that help the learner break down complex ideas, such as through dual coding, the working memory is able to process more of the information to place it into long-term memory.

Dual Coding Theory

Mayer and Moreno (2003) proposed a theory in which information is presented through two channels--one channel helps the learner understand both auditory and verbal information while the other channel manages visual information through pictures. Baddeley (1992) called these channels the visuospatial sketchpad and the phonological loop. When both channels work together, information is processed in the working memory by integrating words and pictures. However, there is still the possibility of cognitive overload if the learner is confronted with either too much information or ideas that are too complex (Sweller & Chandler, 1994). What is important is the working memory codes information from two distinct sources at the same time in order to transfer information into long-term memory (Mayer & Moreno, 2003). As technology changes, there are more opportunities to combine words and pictures using multimedia to improve how working memory puts together information to create long-term memory knowledge.

Cognitive Theory of Multimedia Learning Principle

For Mayer and Moreno (2003), using words and pictures in multimedia as part of education helps create more meaningful and deeper learning. Within the cognitive theory of multimedia learning, words can be print or audio and pictures can be drawings or video. The importance of delivering information through multimedia is to make sure it is presented in ways the learner can still process the information. Cognitive overload can

also happen using multimedia. Educators can develop materials using multimedia that improve how information is presented to limit the challenge of cognitive overload.

Research by Mayer and Sims (1994) detailed how using words and pictures together, especially with the quality of animation available using modern technology, could improve student learning. One of the aspects studied was how well students were able to apply new information to various problem solving situations. The researchers were able to demonstrate using multimedia learning led to better and more complete understanding of the information than presenting the same information using words and pictures separately. Their research suggested learners were able to construct new knowledge based on what they already knew because it was easier to create mental connections or schemata when the audio and visual were presented together in multimedia. Multimedia seemed to be able to increase students' spatial abilities and lessened the chance for cognitive overload (Mayer & Sims, 1994).

Teacher Perspectives Toward Visualization

Visual aids or visualizing concepts students are learning in the classroom are being used frequently in learning processes in different fields and among different ages. Results of studies showed teachers had an awareness about how, when and why to integrate these visuals aids in the class and what benefit these aids offered to students (Rasul, Bukhsh, & Batool, 2011; Yunus, Salehi, & John, 2013). Many studies reflected teacher perspectives regarding when they should apply visuals in lessons that could be applied to any learning environment. Visuals that were used took different shapes and types including images, photographs, drawings, illustrations, maps, and videos. Results indicated teacher perspectives toward those visuals supported a largely positive point of

view toward the implementation of those visual aids in the learning process (Rasul et al., 2011; Yunus et al., 2013).

The first and most widely held teacher perspective toward using visuals in the learning process was the enjoyable part of using them. Visuals grip students' attention and students become more interested in learning because their eyes read the images first; therefore, the images make the students more interested in learning and reading about the topic. The images also extend students' imaginations regarding the concept and help them to start drawing a bigger image in their minds about the idea or concept they are learning (Rasul et al., 2011; Yunus et al., 2013).

Imagery led to a second teacher perspective--visual thinking. Students can better visualize their ideas using visual information, thereby offering students a better understanding of the concept and transferring this abstract idea to a more concrete image. In this way, difficulties were decreased, which led to a third perspective of teachers--motivation. Use of visuals is a motivational tool teachers should use to increase productivity in the learning process and encourage students to learn and become more interested in the topic (Rasul et al., 2011; Yunus et al., 2013).

These studies supported the idea that teachers' perspectives of integrating visuals in the class were mainly positive. They also supported the effect those visuals had on learners from different perspectives and offered ideas to make the learning process happen in a more efficient way.

The Importance of Doodling

Several studies mentioned the use of visuals in learning and how visual could positively affect student learning and performance (McKay, 1999; Mayer, 2009; Stokes,

2002). These studies supported the idea that visuals and images serve an essential need in learning. They also provided evidence that visual literacy is a significant component in education by helping to improve learning when lesson plans combine visuals and words to create better understanding. This strategy leads learners to better remember the lessons.

For instance, more studies have mentioned the importance of children's drawing tasks for the purpose of learning and how this affected the learning process in many areas (Brooks, 2009; King, 2011; Steffani & Selvester, 2009). The authors of those studies stated using drawing as a learning technique helped students visualize their ideas and led them to better learning and understanding (Brooks, 2003; King, 2011; Steffani & Selvester, 2009).

Studies also confirmed the importance of drawing during reading to help students remember information and add enjoyment to the process of reading (Ainsworth et al., 2011). Pfister and Eppler (2012) focused on the importance of sketching and how sketches could support communication and discussion. With regard to doodling, researchers in the few studies available examined (a) how doodling helped students recall information after listening to a tape recording (Andrade, 2010), (b) how doodling could have a significant impact on learning by helping the brain remain active (Schellenbarger, 2011), and (c) doodling encourages students to take an active part in their learning by helping them focus and concentrate more on the classroom setting (Aellig et al., 2009). In short, the cognitive process seemed to be affected by the power of doodling (Brown, 2014). Ainsworth et al. (2011) demonstrated how drawing actually helped students become more interested in the information being presented, especially in science classes.

Chan (2012) studied the link between doodling and task recalling. Because a previous study had linked doodling with a negative effect on recalling auditory tasks (Andrade, 2010), Chan wanted to determine in his study if doodling would be beneficial for recalling a visual task. Fourteen participants were chosen randomly and assigned to one of two groups ("doodling" and "non-doodling"). Each group was shown a slide show with images. Chan (2012) reported a significant difference between the doodling and non-doodling groups in terms of recalling visual tasks. The end result of the study was doodling had a negative effect on recalling visual tasks (Chan, 2012).

There were questions about whether or not students needed to know how to draw, not doodle, in order to learn. If students were using drawing techniques to learn, such as when they were studying science, Ainsworth et al. (2011) suggested there might be some areas where using drawing would actually encourage learning. However, Brown (2014) concluded doodling also improved comprehension and it supported all types of learners. Brown (2014) explained that learners that doodle do so primarily in listening situations:

> The markers and pens come out when people are in a classroom or a meeting room, at a conference, or listening to the radio or television…learners need doodling in order to focus more acutely on what's being said, and they demonstrate better recall when they're allowed to doodle than when they're not. (p. 21)

Brown transferred this process to all types of learners and contexts. Throughout the literature concerning visual literacy, visual thinking, and doodling, what linked the concepts together was how people used visualization to create meaning. Using images to construct understanding of what is being said or visualizing the words on a page are part of how we see the world and how we construct reality (see Figure 1).

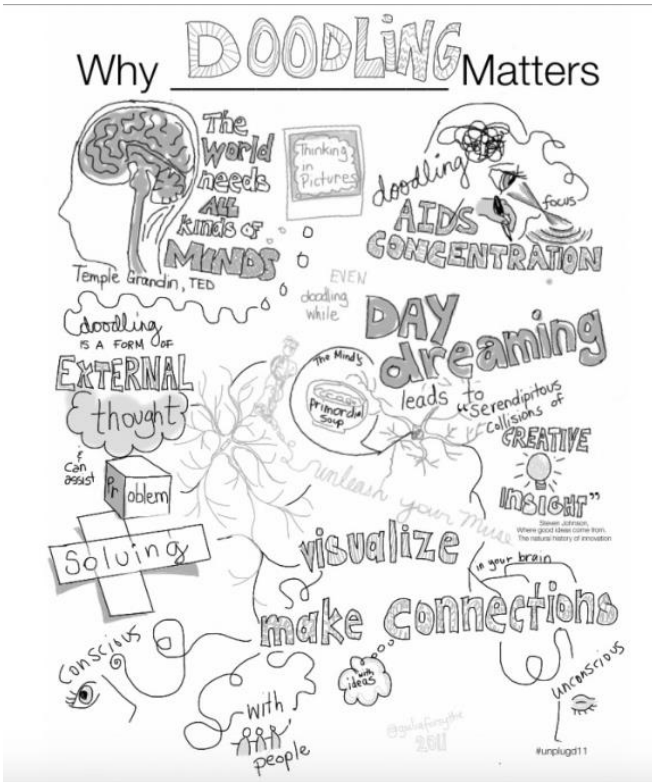

Figure 1. Why doodling matters (Huges & Asakawa, 2014).

Doodling Leads to Visual Thinking

Visual thinking can be defined as a specific teaching method or strategy where students illustrate their thinking process or ideas about a topic (Mathewson, 1999; Walker, 2012). It can be used to help students understand what they are seeing when they view art objects (Moorman, 2013). Visual thinking is simply thinking in pictures (Walker, 2012). We can create a visual thinking environment through different kinds of activities such as drawing, sketching, graphic recording, and doodling. Doodling is one way that leads to visual thinking so it can be considered an effective way to lead to successful learning and recall (Brown, 2014).

Students can learn to use visual thinking to illustrate what they are seeing in their imagination using strategies such as idea-sketching (Walker, 2012). Doodling is one of the forms of transferring what is being thought onto concrete, two-dimensional paper. Mathewson (1999) defined visual-spatial thinking as using vision to see objects and imagery, even ourselves, to form images in our mind's eye when we are not looking. This spatial image can be used to move information into long-term working memory and is essential for cognitive processes. According to Mathewson, spatial thinking is so important it should always be addressed in any learning environment, especially the classroom.

Authors in several studies (Goldschmidt, 2001; Mathewson, 1999; Moorman, 2013; Walker, 2012) showed the importance of visual thinking in different areas. Those studies turned their perspectives toward using visual thinking as a teaching method because they were looking for effective ways to develop observation, understanding, creativity, memorizing, communication ability, and problem solving. They agreed about some previous concepts on how to develop ideas through using visual thinking as a learning strategy. Mathewson (1998) suggested a need for balance between using words and images in teaching strategies. If teachers can help students visualize better through creating images, they will be encouraging a deeper understanding of the material. He also suggested there is still a question about better ways to apply these strategies in the general classroom but insisted that visualization and pictures were extremely important to the cognitive process.

Doodling and Learning Styles

There are three types of learners according to a well-established theory of learning style: visual, auditory, and kinesthetic (Brown, 2014). To assure learners achieve a high level of understanding, the instructor needs to provide different types of learning styles to match all learners' needs (Wilson, 2011).

Many learners might think they are not visual learners so they disregard any term that emphasizes visual learning. Doodling changes that perception. The first thing that comes to the learner's mind when hearing the term "visual learning" is a classroom setting where a teacher presents and explains visuals such as electronic slide shows, photographs, maps, images, etc. In this case, only visual learners in the classroom will enjoy this learning process and this enjoyment will reflect on their understanding toward the concept being presented. So what happens to other students in the classroom with different learning styles? Researchers (Felder & Silverman, 1988; Hunt, 1972; Stokes, 2002) discovered that instructors trying to optimize three types of learning style (visual, auditory, and kinesthetic) found it hard to apply them all at the same time in their teaching methods so they felt they should choose an approach that would achieve the highest level of learning for the majority of their students. In this case, teachers might not consider it effective to the students' learning process by using visuals alone so they might not apply visuals in their classroom.

However, even though it is considered a type of visual learning, doodling is not about showing an image underlined with a quotation to explain concepts to learners. Doodling is rather about students using several functions of their body (e.g., seeing, hearing, touching) to create a learning tool in the form of a purposeful doodle, reflecting

the concept they heard from the teacher. In this way, all three types of learning styles are incorporated into the learning process. How is this accomplished? When students listen to the lecture and use the information to help them create the doodle, the auditory learning style is activated. Then students visualize that information in their minds and translate it to a doodle by recording their visual images onto a piece of paper using their hands and a pencil (a kinesthetic learning style). Finally, by visually imagining their doodles and being able to visually refer back to what they had physically created, their use of visuals, lines, and data is considered to be visual learning.

Brown (2014) indicated using doodling could help all types of learners become more involved in the learning process and achieve a higher level of understanding while a teacher is lecturing. Doodling involves three senses: listening to the lecture (auditory learning), drawing (kinesthetic learning), and creating a picture (visual learning; Brown, 2014). Therefore, by using the doodling process, teachers are able to achieve higher levels of teaching using all three learning styles. In this way, teachers can apply visual literacy in a manner that might be useful for most students. Figure 2 provides a visual representation of the literature review.

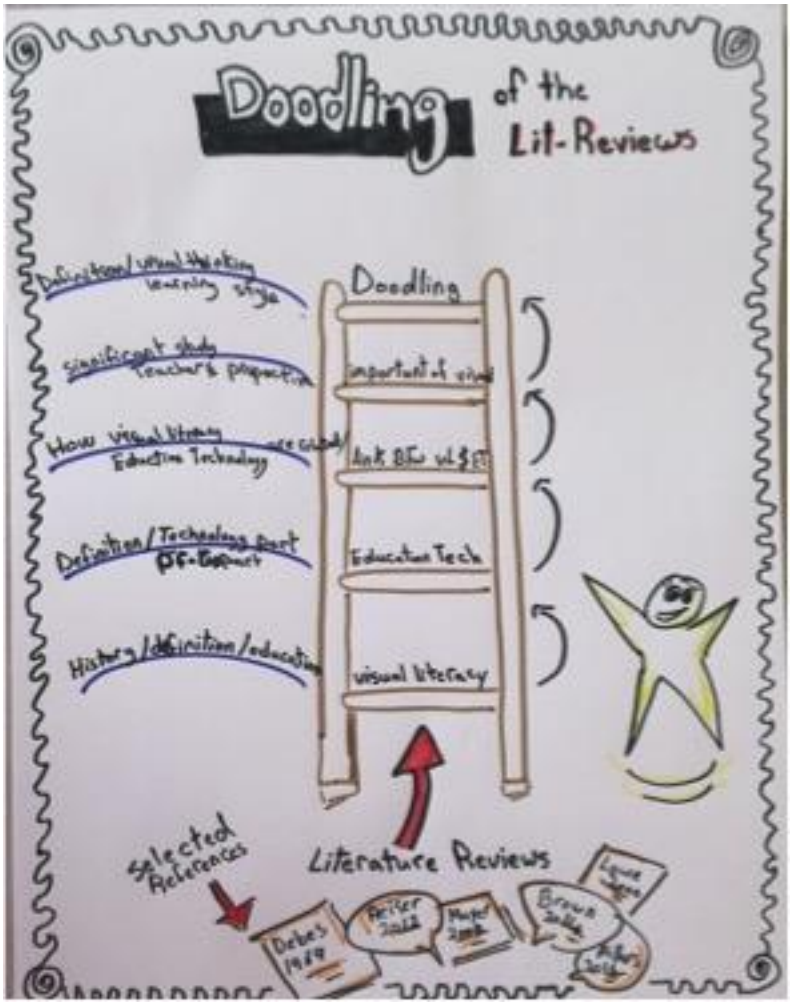

Figure 2. Doodling of the literature-review.

Summary: The Reason for Choosing Doodling in This Study

The term "doodling" was chosen for this study for many reasons. I wanted a concept that gave an easy and simple impression. When learners hear the term, I wanted it to sound fun at the same time as it was useful for the learning process. The simple definition of visual literacy is the ability to read and write images. Many terms fall under the term of "visuals." Each of those visuals functions differently if teachers and students see it from a learning perspective even if all of them at the end are considered to be

visuals. For example, sketching and drawing are types of visuals but to engage in this type of visual, learners need a specific level of skills to establish a suitable sketch or drawing. Doodling is also a type of visual but one does not need any skills to doodle. Anyone can doodle at a level that offers meaning for the learner.

There are many reasons behind bringing purposeful doodling into the educational setting but not many studies have been conducted about the importance of using doodling in education. However, the available studies agree upon the importance of doodling in different settings such as business, psychology, and education (Ainsworth et al., 2011; Andrade, 2010; Brown, 2014). If I were to ask students if they could draw, the answer might often be "no"; while with doodling, the answer most probably would be "yes." Drawing requires at least a minimal level of skill and talent but doodling does not.

Consequently, doodling is a technique that is easy to understand and apply. Learners do not need to have skills to use it. What is needed is a piece of paper and a pencil, although newer technology could also be involved in creating a doodle. The level of skill involved in creating the doodle would depend on a learner's creativity and way of thinking but it would not affect the efficacy of the doodles a learner might create in terms of learning.

Learning theory is the foundation in studying education and is necessary to creating a meaningful learning environment. Educators building instructional design use learning theory to create learning systems that conform to what students need. In general, learning theory is what explains the processes of learning (Harasim, 2012). Cognitive load theory is the one of the most important theories one could use in understanding how

instructional design needs to control the amount of information given to learners at one time (Beatty, 2013).

This dissertation was concerned with a process rather than describing a tool. Visual literacy is a process that has made many significant impacts in many fields. In this dissertation, I mentioned how visual literacy has had a great impact on the field of education technology and how it is important to know the ways we use visual literacy in this field. In this chapter, I demonstrated the connection between visual literacy and education technology using one part of visual literacy in learning--using the doodling technique in the classroom. Having a new technique in the learning process like doodling that combines enjoyment and learning might increase the level of learning performance for students. With the overwhelming amount of information surrounding everyday learners, they need a kind of tool or technique that adds a space for creativity in thinking (and therefore better memory retention).

In the next chapter, I explain the planned method of my study including the theoretical perspective, participants, and the design, instrumentation, and evaluation I used to answer my research questions.

CHAPTER III

METHODOLOGY

This research investigated the importance of utilizing a type of visualization and verbalization known as doodling in the learning process. The claim for the relationship between doodling and learning is students can learn better by visualizing concepts they can learn in the classroom. This visualization practice could lead to development of visualization thinking techniques and also help students to begin improving their visual literacy ability by constantly visualizing their ideas.

The following research questions guided this dissertation:

Q1 What do teachers and students perceive as the affordances and constraints of doodling as part of the learning process in a high school classroom?

- Q1a What are students' perspectives regarding how doodling helps them learn?
- Q1b What are teacher perspectives about the student use of doodling in the learning process?

Q2 How does doodling contribute to the development of students' cognitive processes?

- Q2a How does the use of meaningful doodling in the classroom enhance recalling content knowledge?
- Q2b How does the use of meaningful doodling improve student brainstorming and visualize thinking?
- Q2c How does the use of meaningful doodling improve understanding of complex concepts?

Q2d Is there a difference in the use of meaningful doodling between recalling content knowledge, student brainstorming, visualization, and understanding of complex concepts?

In this research, I used a mixed method design to examine student and teacher perceptions (Q1) and differences between cognitive processes (Q2). Since this research has not been mentioned thoroughly in the field of education, a mixed methods design was the most appropriate way to explain these phenomena descriptively and statistically. Mixed methods helped me understand this area with more breadth, depth and detail than by either a quantitative or qualitative study alone. This design helped optimize the benefits of these two types of research in one research study (Creswell, 2014).

In my study, I collected data by conducting surveys for students and interviews for teachers. Because few teachers are familiar with doodling techniques, the interview process gave me more in-depth ideas about their perspectives and experiences with this new learning technique. By using both surveys and interviews, I believe these data helped to provide me with a greater picture of the phenomena. In the following sections, I detail the study design, methodology, and method for analysis and coding the data.

Research Design

Using qualitative and quantitative research together created "a very powerful mix" of ways to explore a topic (Miles & Huberman, 1994, p. 42). Since I had both qualitative and quantitative research questions and because I collected the data in both ways, the best way to conduct this research was to mix quantitative and qualitative methods (Creswell, 2014). In addition, having both methods added validity to data collected by comparing the evidence of one method against evidence of the other.

Quantitative research provided evidence for any statistical relationship between the use of doodling and developing a cognitive understanding of the material being presented. By having a statistically sufficient number of students with whom to run a quantitative analysis, data gathered using a survey instrument helped to describe and explain this relationship. The findings could be generalized to other similar populations to the extent the results would hold true beyond this research; in other words, the results could be important to other situations where participants were similar to the students in my study. Also, since this study took place in a natural setting instead of a laboratory, the findings could be given ecological validity (the extent to which the results could be generalized to other real-life situations; Remler & Van Ryzin, 2015). A quantitative study allowed me to analyze the behavior of doodling in classrooms where the educational concepts of doodling were applied and generalized it to other situations I had not been able to study (Creswell, 2014).

On the other hand, qualitative methods allowed me to explore how teachers perceived doodling. Since the application of doodling in learning contexts is a new area of research, I was able to interview the participants and gain a deeper understanding of why teachers should allow students to use doodling. The responses from teachers helped explain how teachers and their students perceived doodling and to offer explanations as to how doodling influenced their ability to learn (Creswell, 2014).

There are different types of mixed method designs. Each one of them is different depending on how the researcher wants to combine the qualitative and quantitative parts of the study. I chose an explanatory sequential design for my study (see Figure 3), i.e., I

obtained quantitative data and then followed up with qualitative data to give further explanation about the answers I received from the survey (Creswell, 2014).

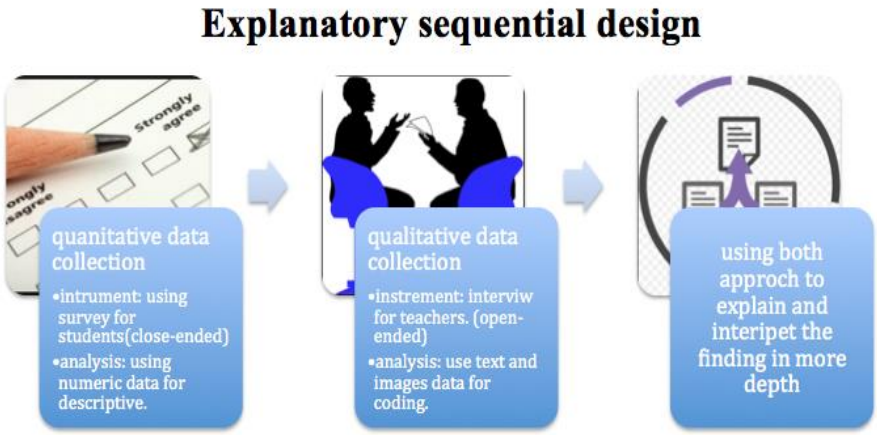

Figure 3. Explanatory sequential design.

An explanatory sequential design is sometimes referred to as a two-phase model (Creswell, 2014). The order of collecting the data is important in this design. The quantitative data is collected first. The results of the quantitative data give structure to the picture the qualitative data provides. Qualitative data add more depth to the results. Using both approaches creates a more complete representation of the data (Creswell, 2014). In my study, I collected the data using a survey instrument for the students followed by interview questions for the teachers using information from the survey (see Figure 4). These interviews helped me get a more in-depth understanding of the areas on which I needed more explanation from the quantitative survey.

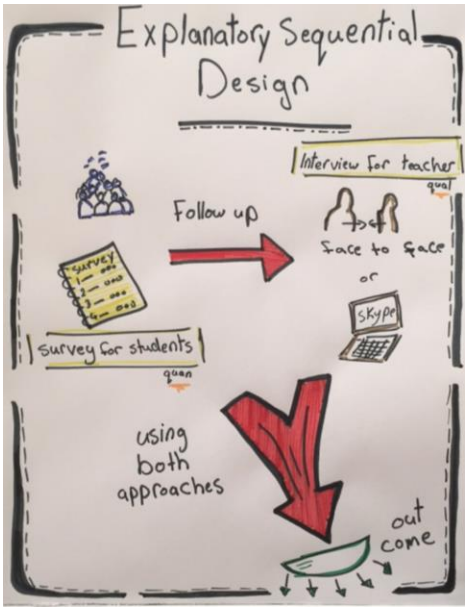

Figure 4. A doodle describing explanatory design.

Theoretical Perspective

Constructivism has been defined as "a theory or philosophy of learning based on the idea the knowledge is constructed by the knower based on mental activity" (Reiser & Dempsey, 2012, p. 45). The theoretical perspective known as constructivism helped explain the importance doodling could have in our everyday experiences. Constructivism is a theoretical approach stating people construct meaning from what they do in their everyday lives (Crotty, 1998). As people engage in everyday activities, they interpret what they are doing and how others perceive them. In this way, they are continually constructing their own reality. The constructivism approach applied to education is learner centered, where students actively seek to understand meaning, as opposed to a traditional learning environment that relies on an instructor to passively teach knowledge.

However, in constructivist learning, the instructor is still necessary to scaffold the learning and establish a conducive learning space.

The constructivist theoretical approach explains how individuals use their unique experiences to help make sense of new ideas and then build new knowledge. Harasim (2012) explored the idea that it is normal for learners to investigate any new concept and adapt to the new concept until it becomes a part of the whole knowledge of the learner. This process is dependent on the learner's abilities and the immediate learning environment. Constructivism suggests the learner is actively seeking or investigating ways to build or construct knowledge. The learner takes part in the process by using previous experience and knowledge to help understand new concepts. Constructivism uses both cognitive and learning theories to explore how learners construct new knowledge.

According to Murphy (1997), "In the constructivist perspective, knowledge is constructed by the individual through his interactions with his environment" (p. 3). Learners construct knowledge about the world by experiencing the world. This construction of knowledge is a way to make sense of everyday circumstances and find meaning by interpreting reality based on experiences including interactions with others. Other theories explain knowledge is passively taught but constructivism suggests learners must take an active role in gaining knowledge through experience, communication, and interpretation.

Murphy (1997) stated many different forms of constructivist approaches do not all agree on their function and characteristics. However, there are central themes and characteristics common to constructivism. The major characteristic is the roles of teacher

and learner. The teacher is seen as more of a facilitator or a coach who gives the student certain tools or the "mechanics of knowledge transfer" (Murphy, 1997, p. 7) to guide learners as they construct knowledge. The teacher still has an essential role of guiding learners by giving them feedback and also largely controls the learning environment (Harasim, 2012). Teachers use scaffolding as a method to support learners as they construct knowledge. Scaffolding is a strategy that shows the student how to find information and the teacher is available to answer questions while the student seeks out the answers on his/her own (Harasim, 2012).

A second major characteristic of constructivism is the definition of learning. Murphy (1997) states in constructivism, "Learning is not a stimulus-response phenomenon. It requires self-regulation and the building of conceptual structures through reflection and abstraction" (p. 8). The role of learning is more about how students gain knowledge rather than how much they know. Using critical thinking skills is an aspect of learning in constructivism. According to Murphy, other characteristics include "situated cognition, anchored instruction, apprenticeship learning, problem-based learning, generative learning, constructionism, and exploratory learning" (p. 9).

The constructivist theory focuses on four types of teaching methods: active learning, learning by doing, scaffolded learning, and collaborative learning (Harasim, 2012, p. 68). Active learning discusses how the student should be active in the classroom, e.g., being an active part in discussions, actively applying what is learned, and being able to narrate experiences related to specific topics. The instructor guides these activities by controlling the discussions and giving feedback. The second type of teaching--learning by doing--allows learners to explore the world outside the classroom,

to investigate that world, and determine what they need to solve problems or answer questions. Hands-on exploration allows learners to construct meaningful learning based on the experience gained by doing. In scaffolded learning, the third type of teaching method, the instructor is available to support learners as they struggle with new concepts. Instructors can use a variety of tools to help build knowledge about new ideas, especially if the concepts are particularly difficult to understand. As students become familiar with the concepts, instructors are not needed as much to provide support. This is part of self-directed learning by the student. The fourth type of teaching method is collaborative learning. It is important learners understand that collaboration is not competition. Sometimes, competition between group members can create problems within the group. However, collaboration is teamwork with students sharing ideas and supporting each other (Harasim, 2012).

The act of purposeful doodling can help the student visualize abstract thinking and complex concepts. These visual conceptual structures help the student reflect on what is being taught. The student can then decide for him/herself how an individual doodle fits with what he/she is learning and can construct new knowledge. This gets the student involved in the process of learning through constructive visualization. In essence, this is the student becoming involved in self-regulated learning.

Method

The Setting (or Context)

Prior to conducting this research, I sought approval from the University of Northern Colorado's Institutional Review Board. Upon approval, I proceeded in my research (see Appendix A). I selected participants from three classes in a high school

located in a south-eastern portion of the U.S. coastline. As of 2016, this high school numbered about 700 students and 60 staff members. Each class has about 20-25 students and the age range of the students is between 14 and 19. The participants from those three classes are applying doodling technique in their learning process so they are familiar with this concept and the role of this concept on the learning process.

Participants

Since the practice of incorporating doodling in the learning process is very new, not many participants (either teachers or students) were available for use in my study. In this study, I used a nonprobability purposive sampling method, which for a qualitative study is considered the most appropriate sampling strategy (Merriam, 2009, p. 77). I also used this sampling method because the number of participants to recruit was few and this method works well for studies where not many people are using the technique to be studied (Creswell, 2014).

As this study was a mixed method study, the target population for my quantitative survey consisted of students who had been using doodling in their learning processes. Because of the scarcity of classes using doodling as a cognitive tool at this time, my sample was purposive and convenient. The sample size was 64 high school students whose age ranged between 14- to 19-years-old.

For the qualitative interviews, the sample size was three teachers in the K-12 school system. The criterion used in selecting the teachers was they needed to have used the technique of doodling as a way of supporting students' thinking in their teaching. The teachers selected for this study were well established in using doodling as a learning technique to promote students' thinking in the classes as well as being published authors

on the subject. Students in the teachers' classrooms were familiar with doodling because they had previously used it in class. These participants were chosen because they were identified as being expert in the use of doodling because of their experience with it and their expertise surrounding how it influenced thinking through practical experience. The researcher made the assumption that because little research existed on doodling as a cognitive learning technique and few teachers or students used it, this purposeful sample would provide the most detailed information to address the research questions.

All participants signed consent forms stating participation was voluntary and they could choose to end the interview at any time (see Appendix B for the teacher's consent form, Appendix C for the parental consent form, and Appendix D for the student's assent form). I contacted the teachers and students online since they all reside out of state.

Potential Benefits to the Participants

This research explored the importance of doodling on the learning process and how this technique might have a positive effect on students' ability to visualize their thinking and enhance their visual literacy. I provided my findings to both student and teacher participants so they could discuss ways doodling was used and how it might increase learning. I also explained how doodling is part of the field of educational technology as a technique that enhances learning. In that way, I hoped to improve the learning environments already using doodling as well as offer my research findings to other schools not presently using doodling as a tool for learning in hopes of offering a new way to enhance visual literacy.

Consent Forms

Before participation in the study began, I asked participants to complete an assent form (if they were under the age of 18) or consent form (if they were above the age of 18; this included parents of children under the age of 18) describing the research, outlining their participation, stating the risks and benefits of participation to them, and providing a list of rights for participation such as the ability to withdraw at any time for any reason.

Instrumentation and Data Collection

Since this was a mixed methods research, I used a survey to answer the quantitative research questions and interviews to answer the qualitative research questions.

Survey. A survey was used to determine whether doodling influenced the learning process from students' perspectives (research question 1). Open-ended questions for the survey were included to help provide information for teacher interviews to determine the students' perspectives of using doodling in classroom. Research question 2 asked how doodling contributed to the development of cognitive understanding of content-based complex concepts. For this, I asked 16 questions that measured the reflection of students as to whether or not they thought doodling affected different cognitive areas (visualizing thinking, recalling content knowledge, improving understanding of complex concepts, and brainstorming); four more questions were asked to assess whether or not students enjoyed using the doodling technique in learning for a total of 20 questions. Then I used an analysis of variance (ANOVA) to see if there were differences in the way students thought doodling affected the different cognitive areas.

In constructing my survey, I first attempted to find pre-built surveys concerning the field of integrating visuals in the learning process. However, none of them seemed appropriate to my study in terms of determining students' perspectives and habits of taking visual notes in the educational setting. Since I could not find an appropriate survey for this purpose, I designed a survey to meet the needs of this study (see Appendix E). The survey addressed five factors: ability to visualize thinking, memorization, complex ideas, brainstorming, and enjoyment. I designed these factors using previous research I conducted about the experience of an expert on doodling and how doodling was important while listening to a lecture (Zeyab, 2015). After interviewing the expert in doodling, a thematic approach was applied to code the data, which resulted in five themes. Since these themes applied to doodling and learning, I decided to use them in this study to examine students' perspectives about these factors. This instrument was completed online and was used to collect information from participants. The survey was prefaced by an electronic parental consent form (see Appendix C) and an assent form for students who are under the age of 18 (see Appendix D).

This survey was conducted during the fall semester of the 2016 academic year. Course instructors volunteered to conduct the survey during class time. Due to the limited nature of the survey, students needed only 10 to 20 minutes to complete the questions (see Figure 5 for factors the survey measured).

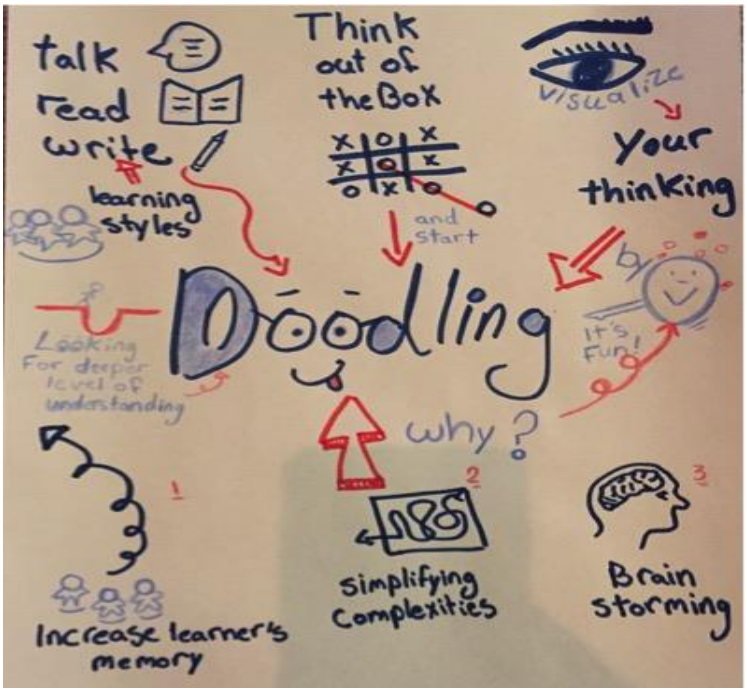

Figure 5. Factors the survey measured.

Interviews. For the qualitative part of the research, an in-depth semi-structured interview was used to collect information from each teacher participants. The semi-structured interview allowed me to ask questions in a more conversational style instead of a predetermined wording or order (Merriam, 2009). Interviews were conducted face-to-face either in person or using Skype© technology and were audio-recorded to collect information from the participants. Participants were first asked questions designed to measure their experience in using doodling as a thinking method (see Appendix F). Analysis of the survey results allowed me to follow the first set of questions with specific interview questions related to the outcome of the quantitative data in order to gather specific details related to the study. Each interview took approximately 45-60 minutes.

An interview structure was chosen because it offered the best opportunity to get more thorough information from only a few participants (Merriam, 2009).

Reliability and Validity

In quantitative research, reliability comes from the ability to trust the consistency of scores for a given sample under certain conditions at either one or multiple times. On the other hand, validity of the quantitative data is simply to see if the instrument is measuring what it is supposed to be measuring in the proper context and for the correct reasons (Cook & Beckman, 2006; Creswell, 2014).

For the quantitative part of this study, since the study was new in this area with a lack of literature and the number of participants was small, it was difficult to run a pilot study. However, upon completion of this study, I used SPSS to determine the validity and reliability of my survey by first conducting a factor analysis, which was run for the cognitive factors to be sure I was measuring each of the four factors (ability to visualize thinking, memorization, complex ideas, and brainstorming) in the construct correctly. I then checked for internal consistency using Cronbach's alpha, which indicated how strongly the questions in the survey instrument were consistent within each factor (Creswell, 2014).

Construct and content validity were applied in this case to make sure I was appropriately measuring the benefits of doodling in terms of cognitive understanding. In designing the survey, an expert in the field and a teacher were asked to review and revise the survey questions to see if they were in alignment with the construct of cognitive understanding. They confirmed the questions covered all the factors I believed were

important for cognitive reasoning and visual literacy. This expert analysis led to improved validity (Creswell, 2014).

Trustworthiness

According to Merriam (2009), reliability and validity in qualitative research are somewhat different than in quantitative research. Although qualitative research cannot be proven reliable or valid, there are ways to maximize efforts at a higher level. In qualitative data, it is important to make sure the method, such as the interview, relates to the research questions to establish validity. However, since qualitative data rely on the interpretation of the data by the researcher, I needed to make sure my interpretation was clear and understandable and aligned with the intent of the participants.

Trustworthiness in a qualitative research design can be enhanced in several different ways. I chose various methods to measure credibility (internal validity). For example, I used member checking by sending my findings to the participants to get their responses regarding the accuracy. Based on their responses, I made minor changes in my arrangement of themes.

Saturation was another way to verify validity; I was able to see from the answers that many of the same comments were repeated over and over. Merriam (2009) stated saturation occurs when "the data and emerging findings must feel saturated; that is, you begin to see or hear the same thing over and over again" (p. 219). For this study, I used triangulation, which uses different sources of data to verify and understand the findings that begin to emerge from the data. In this case, the responses from multiple participants using both survey and interview methods were triangulated to verify the findings and to investigate differences to understand why they were present (Merriam, 2009).

To ensure dependability (reliability), I made sure the results were consistent with the data collected. I asked if the results made sense and if the general reader would be able to relate to the information presented. The notes I used for validity were also valuable for reliability because they served as an audit trail for how I organized the study. Using my notes, other researchers could see how I obtained my results (Merriam, 2009).

Carcary (2009) described how using a research audit trail could help determine if the qualitative research was trustworthy. In my audit trail, I recorded all the steps I took, the kinds of decisions I made about how to interpret the data, and all the choices I made about the methods, the findings, and the conclusions. In this way, another researcher could build a study to replicate what my study had done (referred to in qualitative research as transferability). Since there was little research on this particular subject of using doodling, being able to replicate my study would add to the reliability and transferability of my study. This could help lead to further research on this subject.

Data Analysis

After the survey data were collected, I used factor analysis and Cronbach's alpha to determine if the survey was valid and reliable as was mentioned earlier in the reliability section. Then I grouped the survey responses into classifications used to respond to the research questions. Descriptive statistical analysis methods were used to answer research questions regarding student perceptions and an ANOVA was used to look at differences in cognitive processes. I then used the data generated from the survey analysis to construct the interview questions included in the interview protocol with the teachers. The inclusion of questions developed based on the quantitative data analysis

provided an opportunity to find out more about the students' responses by asking the teachers how they interpreted students' responses.

After the interviews were completed, the oral recordings were transcribed. An organizational method for the transcriptions was created to keep all information for each specific participant together including personal notes. After all the data were collected, content analysis began utilizing the constant-comparison method, which compares the responses from two different groups (Creswell, 2014). In a quantitative study, a comparative method usually compares the experimental group to the control group to demonstrate if the intervention of the independent variable caused a change in the dependent variable. In qualitative research, the constant-comparative method compares the responses of interview questions from one participant to another to compare for like and unlike responses. For instance, when I was analyzing how teachers and students perceived doodling, I made comparisons of suggestions for how doodling could be used in the classroom. These categories were used to find similarities and differences that helped me describe the central phenomenon.

Researcher Stance

The area of visual literacy interested me because visual learning is how I learn. I was also interested in finding creative ways to help people think. This led to understanding how visual thinking worked; I believed one way to learn was through doodling. For me, doodling was not simply mindless drawing--it helped me concentrate. I wanted to conduct research that could demonstrate how important doodling could be and perhaps change teachers' perceptions of the importance of doodling. If people paid attention to their doodling, they could realize how much it could help them. This is

known as mindful doodling. Because I believed doodling and visualization were meaningful to learning, as a researcher I needed to be aware of this perspective and account for it in my analysis.

As I was researching visual literacy, I found information about the efficacy of mindful doodling. I realized doodling had not been well-researched, which was one reason why I wanted to know more about how doodling worked. I wanted to add to a growing body of knowledge about this little-known tool for concentration and improving memory. One of my assumptions was the people I interviewed used doodling purposefully. I was interested in their experiences with doodling because I wanted to be able to teach others how to use mindful doodling. As Merriam (2009) pointed out, this kind of purposeful sampling is "based on the assumption that the investigator wants to discover, understand, and gain insight" into the subject (p. 77). As the investigator, I wanted to know how and why doodling was important to people who were able to use it as part of their jobs and in their everyday lives. My assumption that purposeful doodling could be beneficial demonstrated my personal bias. In analyzing the data, it was important that I was able to separate my bias from the findings. One way to do this was to ask an expert in doodling to review the data and the findings. Also, when I examined student and teacher responses, I not only looked for positive learning benefits of doodling but I examined negative factors to see whether or not doodling was seen as truly effective. This helped establish both the reliability and the validity of the study as well as guarded against any personal bias I brought to interpreting the data.

Research on the effects of doodling was limited. The majority of those few studies indicated doodling could be beneficial. However, one study (Chan, 2012)

demonstrated doodling had no greater effect on recalling information. There was a possibility my research might show that doodling had little to no effect on recalling information. However, this did not lessen the need for more research on the subject. Only by conducting further research can we define doodling and demonstrate to what degree doodling might be beneficial. Most articles that mentioned the benefits of doodling were based on only two previous studies (Aellig et al., 2009; Ainsworth et al., 2011; Andrade, 2010).

Summary

In this chapter, I include detailed information about how this study was conducted, the design I used, and why I wanted to use it. Participants for this study were both students and teachers who were using doodling as a learning strategy in the classroom. Participants were purposefully chosen. Students completed a survey that used a Likert scale to determine to what degree students perceived doodling benefited them. Teachers were interviewed so they could verify students' responses and determine their perspectives about using doodling. I used a constant-comparison method to analyze the data collected from the interviews. Responses to the survey were analyzed using a descriptive method. In addition, I asked an expert in this field to review the data to help avoid personal bias and to build validity and reliability.

CHAPTER IV

FINDINGS

As discussed in previous chapters, this study was about how teacher and students perceived doodling regarding students' learning processes and how this might or might not have affected their cognitive development. This study also reviewed the concept of doodling and how it might be used as a helpful tool for education and learning. Quantitatively, this mixed methods study explored the effect doodling had on students' performance in the learning process and used a survey to measure five factors: enjoyment, memorization or recall, complex ideas, brainstorming, and the ability to visualize thinking; these factors were defined based on previous qualitative work I had accomplished in this field (Zeyab, 2015). Qualitatively, data were collected by interviewing three teachers who applied and practiced doodling with their students in the classroom to explore their perspectives of the five factors and how doodling might help students. Constant comparative analysis was used to determine if the participants agreed or disagreed with each other in answering the interview questions. Comparing how their responses were alike or different gave me a deeper understanding about the integration of doodling in learning and how that might affect student performance in learning.

I also wanted to understand doodling from student perspectives. Therefore, I included an open-ended question for the students in their surveys by asking how they incorporated doodling in their learning process. To begin the analysis, I coded each

interview with the teachers and the open-ended questions from the students, looking for key words, ideas, and concepts. After coding each participant's answers, I started to find similarities and differences. These similarities and differences became the basis of the themes I built to interpret my data results and discussion.

Quantitative Findings

Since this is a mixed method study, this section includes the results from the quantitative survey responses and clarifies the statistical output I obtained from this survey.

Demographic Questions

This section contains demographic information about all participants who answered both the survey and the interviews. Table 1 shows demographics for students (n = 64) and teachers (n = 3) including race, gender, and age. The section for teachers differs only by including a question about years of teaching experience. Figure 6 provides my doodle regarding the demographic questions.

Table 1

Participant Responses to Demographic Questions

Demographics for Students			
Question	Category	*α*	%
1. What is your gender?	Male	29	45.0
	Female	35	54.7
2. What is your age?	12-15	44	68.8
	15-17	14	21.9
	Above 17	6	9.4
3. What is your primary language?	English	23	35.9
	Spanish	41	64.1
Demographics for Teachers			
1. What is your gender?	Male	0	
	Female	3	
2. What is your age?	30-40	1	
	40-50	1	
	No answer	1	
3. What is your teaching experience?	Less than 10 years	0	
	10 years and above	3	

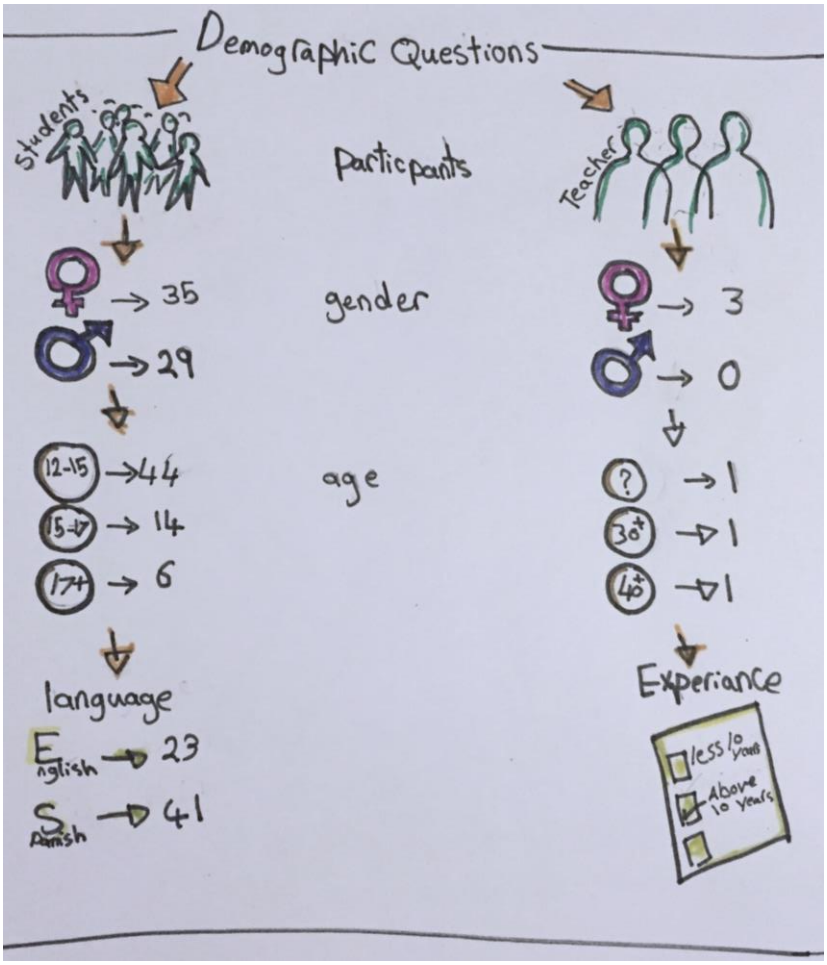

Figure 6. Doodling of demographic questions.

Validity and Reliability Established

As mentioned earlier, no pilot study was conducted before collecting data because of the limited number of participants available. For that reason, after collecting the data, I used SPSS© to determine the validity and reliability of the survey. This helped to determine if all of the factors I included in the survey were constructed correctly including visualization, recall information, complexity, brainstorming, and enjoyment.

Since this survey was being used for the first time, I conducted an exploratory factor analysis to see if the items were correctly grouped to identify the theoretical factors

listed above (see Figure 7). To complete the principal component analysis (PCA), four assumptions had to be met. The first assumption was related to the study design--the variables should be continuous. For purposes of this analysis, a Likert scale was considered acceptable; thus, I met this assumption since I used the Likert scale in my survey. The second assumption reflected the nature of the data--there should be a linear relationship between the variables. I met this assumption when I ran the data though SPSS. The third assumption was also related to the nature of the data--there should be no outliers. Because I only used Likert scales in my survey, there were no outliers; thus, this assumption was also met. The fourth assumption was the sample should have at least 5 to 10 cases per variable. In my case, I had four variables for a sample of 64 students so this assumption was also met.

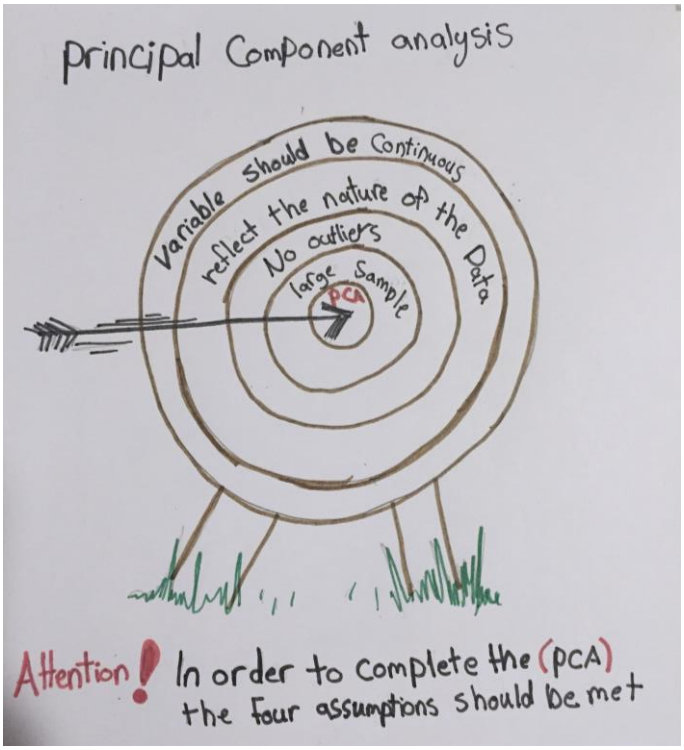

Figure 7. Doodling of principal component analysis.

A PCA was run on the 16-question questionnaire that measured the importance of using doodling in the learning process. The suitability of a PCA was assessed prior to analysis. Inspection of the correlation matrix showed all variables had at least one correlation coefficient greater than 0.3. An overall Kaiser-Meyer-Olkin (KMO) measure was 0.885 with individual KMO measures all greater than 0.7, which were classifications of middling to meritorious according to Kaiser (1974). Bartlett's test of sphericity was statistically significant ($p < .0005$), indicating the data were likely factorizable.

The PCA revealed three components had eigenvalues greater than one, which explained 51.6%, 8.3%, and 6.3% of the total variance, respectively, for a total of 66.2%. Visual inspection of the scree plot indicated two to three components should be retained (Cattell, 1966). However, the three-component solution failed to meet the interpretability criterion in terms of my theory of components (see Table 2). Therefore, I attempted to see if another rotation would fit my data better, even forcing the data into a four-components solution using various oblique rotations (orthogonal rotations were not used because this type of rotation implied the factors were not correlated; in this case, the factors were correlated). After several attempts, I came to the conclusion that only one to three components were significant regardless of the type of rotation I used.

Internal Consistency

A check for internal consistency (reliability) using Cronbach's alpha was used to discover how strongly the questions in the survey instrument were consistent within each factor. Table 3 shows the results for reliability for all of the factors; the total survey consisted of 20 items and each factor had four items. Since Cronbach's alpha was between .803 and .940, the reliability was considered high. Where the values of

Cronbach's alpha were > 0.66, the survey items identified were reliable. However, the presence of multicollinearity made these factors suspect since they might be describing three or fewer true factors.

Table 2

Reliability Statistics

Item	α	*N*
Visualization	.803	4
Recall	.865	4
Complexity	.828	4
Brainstorming	.809	4
Enjoyment	.865	4
All Items	.840	20

Table 3

*Factor Analysis: Pattern Matrix**

Factor	Component		
	1	2	3
2--From doodling, I learn how to visualize my thinking	.808		
3--Doodling helps me present my idea visually	.919		
5--Doodling helps me remember things better	.773		
6--Doodling helps me recall my information later	.785		
8--Doodling helps me to actively process ideas which helps in recalling information better	.935		
12--Doodling helps me learn abstract concepts easily	.596		
15--Doodling helps me express my ideas and thoughts on a subject	.512		**.403**
1--I doodle while I'm listening to the teacher		.997	
4--I like to draw about a concept when I learn about it		.616	
7--Doodling helps me feel like I'm taking an active part in my learning which helps me recall the concept		.503	
9--Doodling helps me break down concepts		.697	
10--Doodling while listening to the teacher helps keep me focused		.543	
11--Doodling facilitates the understanding of complex ideas		.630	
13-Doodling helps me brainstorm			.910
14-Doodling motivates me to brainstorm			.722
16-Doodling helps me to get as many ideas as possible			.825

Note. Extraction Method: Principal Component Analysis. Rotation Method: Promax with Kaiser Normalization.

*Rotation converged in six iterations. All correlations less than .4 were suppressed for clarity. Number in bold denotes lower correlation that coincided with the higher correlation for that item.

Quantitative Research Questions

The following statistics were gathered in response to the second quantitative research question.

Q2 How does doodling contribute to the development of students' cognitive processes?

Q2a How does the use of meaningful doodling in the classroom enhance recalling content knowledge?

Q2b How does the use of meaningful doodling improve student brainstorming and visualize thinking?

Q2c How does the use of meaningful doodling improve understanding of complex concepts?

Q2d Is there a difference in the use of meaningful doodling between recalling content knowledge, student brainstorming, visualization, and understanding of complex concepts?

This research question investigated the importance of doodling on cognitive development. I wanted to see if doodling could improve cognitive development while being used in the learning process as a learning tool. Cognitive development was measured using the survey to see which cognitive factors were affected more by meaningful doodling: visualization, recall, complexity, and brainstorming.

For this research question, descriptive analysis was used to examine how doodling contributed to the development of students' cognitive processes. Each factor was operationalized by asking four questions using a 4-point Likert scale for a total of 16 questions related to cognitive understanding. Table 4 shows the means and standard deviations for all the factors together and then each factor separately; the means were between 2.63 and 2.86, indicating the responses were all positive. This is followed by a frequency table that shows each question asked on the survey (see Table 5).

Table 4

Mean and Standard Deviation Results for All Four Factors

Factor	*M*	*SD*	*N*
Visualization	2.65	0.64	64
Recalling	2.80	0.62	64
Complexity	2.63	0.58	64
Brainstorming	2.86	0.57	64

Table 5

Frequencies for Visualization Factor

Question	Strongly disagree	*N*	Disagree	*N*	Agree	*N*	Strongly agree	*N*	Total
1--I doodle while I'm listening to the teacher *M* = 2.58 *SD* = .832	10.94%	7	31.25%	20	46.88%	30	10.94%	7	64
2--From doodling, I learn how to visualize my thinking *M* = 2.72 *SD* = .863	9.38%	6	26.56%	17	46.88%	30	17.19%	11	64
3--Doodling help me present my idea visually *M* = 2.73 *SD* = .782	6.25%	4	28.13%	18	51.56%	33	14.06%	9	64
4--I like to draw about a concept when I learn about it *M* = 2.44 *SD* = .567	7.81%	5	48.44%	31	35.94%	23	7.81%	5	64

Note. Figures might not add to 100% due to rounding.

From the students' responses shown in Table 5, a majority of students either agreed or strongly agreed with questions 1-3 (an average of 59%), suggesting these

students believed doodling helped them visualize their learning. However, a majority of students disagreed with question 4, i.e., the majority of students did not like to draw a concept when they learned about it. Figure 8 provides a graph of the visualization factor.

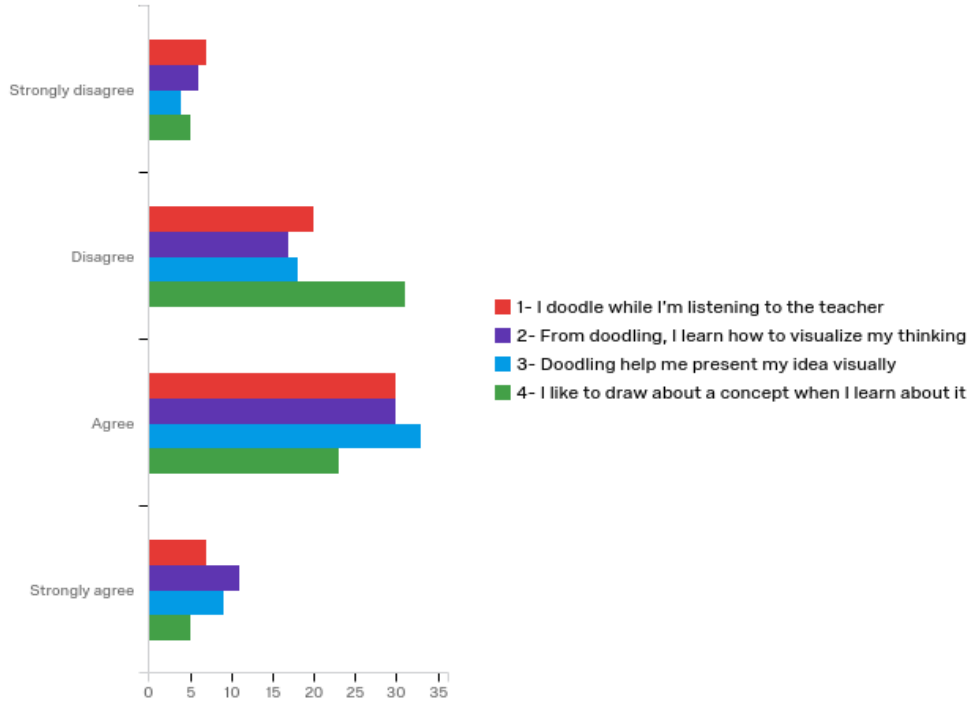

Figure 8. Graph of visualization factor.

From the students' responses on the recall information factor, the majority was slightly larger with either agreed or strongly agreed with questions 5-8 (an average of 74%), which indicated students were sure doodling helped them with the recall of information and with memorization (see Table 6). On the other hand, nearly 29% of students considered doodling was not a significant tool for recalling information/ memorization. Figure 9 provides a graph of the recall information/memorization factor.

Table 6

Frequencies for Recall Information/Memorization Factor

Question	Strongly disagree	*N*	Disagree	*N*	Agree	*N*	Strongly agree	*N*	Total
5--Doodling helps me remember things better *M* = 2.86 *SD* = .814	6.25%	4	21.88%	14	51.56%	33	20.31%	13	64
6--Doodling helps me recall my information later *M* = 2.81 *SD* = .732	6.25%	4	18.75%	12	62.50%	40	12.50%	8	64
7--Doodling helps me feel like I'm taking an active part in my learning which helps me recall the concept *M* = 2.70 *SD* =.706	4.69%	3	29.69%	19	56.25%	36	9.38%	6	64
8--Doodling helps me to actively process ideas which helps in recalling information better *M* = 2.83 *SD* = .703	4.69%	3	20.31%	13	62.50%	40	12.50%	8	64

Note: Figures might not add to 100% due to rounding.

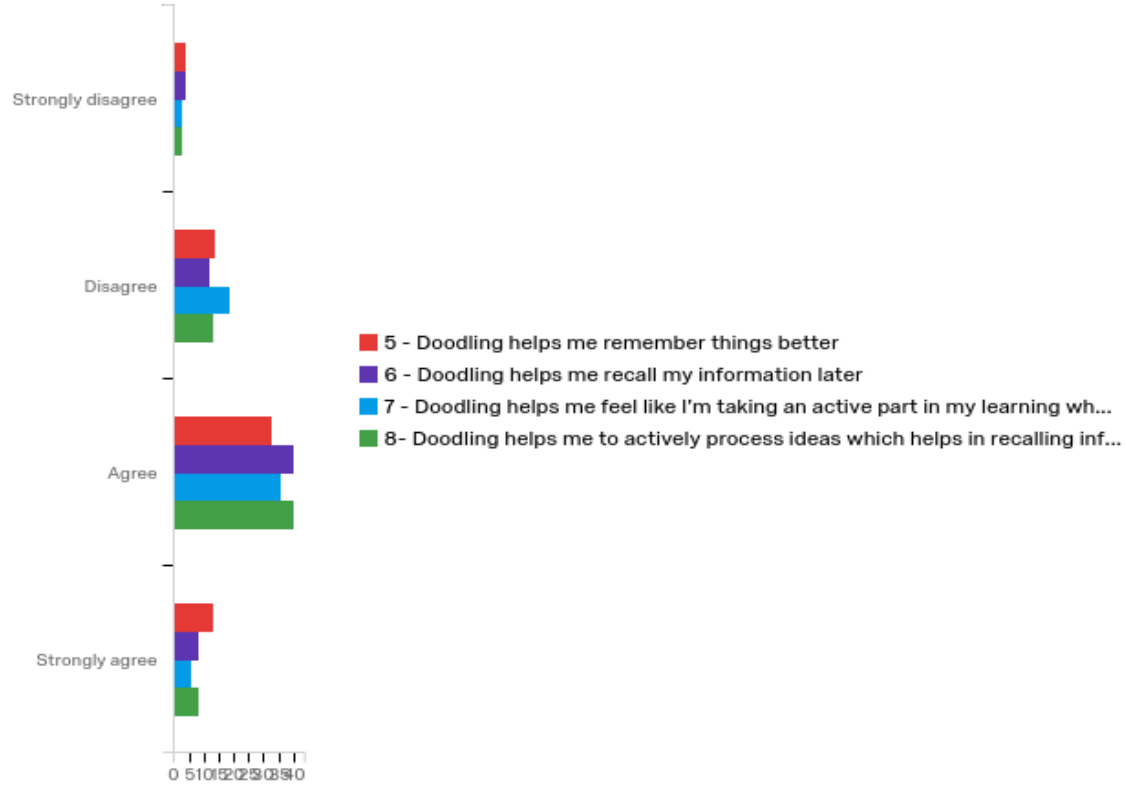

Figure 9. Graph of recall information/memorization.

A total of 60% of students either agreed or strongly agreed with questions 9-12, indicating doodling helped them understand complex ideas (see Table 7). This left a minority of about 40% who disagreed or strongly disagreed that doodling was a significant tool for helping them understand complex ideas. Figure 10 provides a graph of the complexity factor.

Table 7

Frequencies for Complexity Factor

Question	Strongly disagree	*N*	Disagree	*N*	Agree	*N*	Strongly agree	*N*	Total
9--Doodling helps me break down concepts *M* = 2.69 *SD* = .664	3.13%	2	32.81%	21	56.25%	36	7.81%	5	64
10--Doodling while listening to the teacher helps keep me focused *M* = 2.48 *SD* = .691	9.38%	6	40.63%	26	42.19%	27	7.81%	5	64
11--Doodling facilitates the understanding of complex ideas *M* = 2.67 *SD* = .703	3.13%	2	35.94%	23	51.56%	33	9.38%	6	64
12--Doodling helps me learn abstract concepts easily *M* = 2.69 *SD* = .732	4.69%	3	32.81%	21	51.56%	33	10.94%	7	64

Note. Figures might not add to 100% due to rounding.

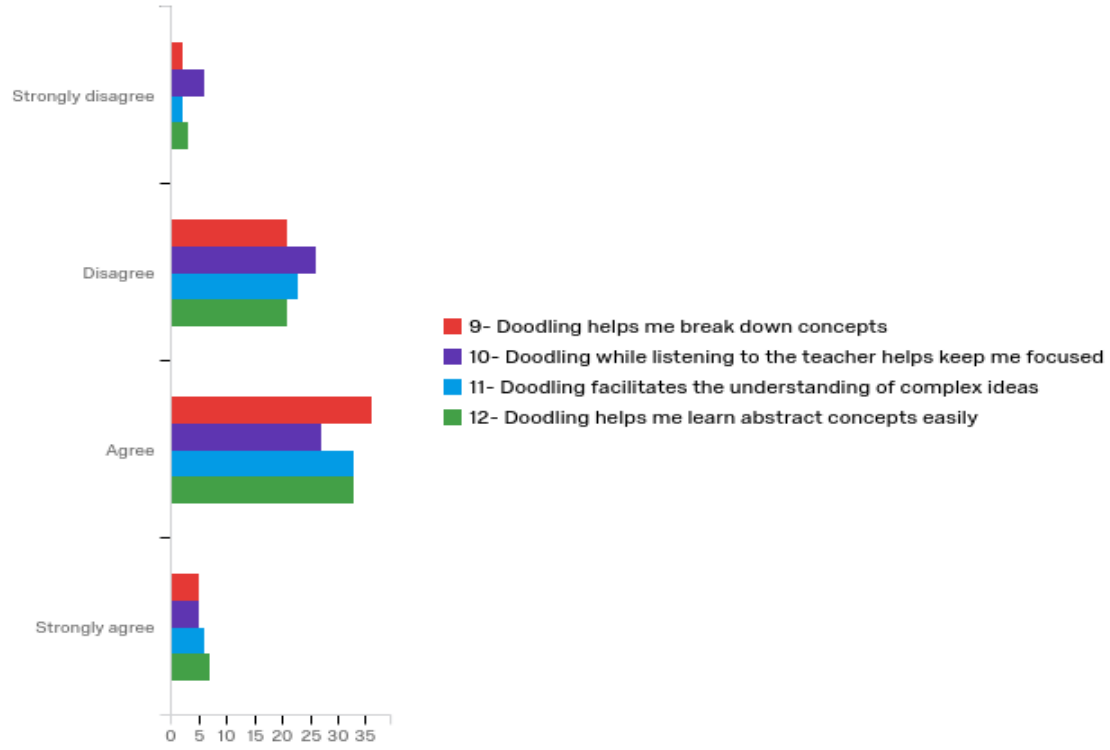

Figure 10. Graph of complexity factor.

The differences here are larger than previous questions with 75% of the participants either agreeing or strongly agreeing that doodling helped them with brainstorming (see Table 8). A minority of students either disagreed or strongly disagreed (an average of 26%), indicating they did not consider doodling to be a significant tool for brainstorming. Figure 11 provides a visual representation of the brainstorming factor.

Table 8

Frequencies for Brainstorming Factor

Question	Strongly Disagree	*N*	Disagree	*N*	Agree	*N*	Strongly agree	*N*	Total
13--Doodling helps me brainstorm *M* = 2.97 *SD* = .734	4.69%	3	14.06%	9	60.94%	39	20.31%	13	64
14--Doodling motivates me to brainstorm *M* = 2.75 *SD* = .713	4.69%	3	26.56%	17	57.81%	37	10.94%	7	64
15--Doodling helps me express my ideas and thoughts on a subject *M* = 2.84 *SD* = .695	4.69%	3	18.75%	12	64.06%	41	12.50%	8	64
16--Doodling helps me to get as many ideas as possible *M* = 2.86 *SD* = .710	4.69%	3	18.75%	12	62.50%	40	14.06%	9	64

Note. Figures might not add to 100% due to rounding.

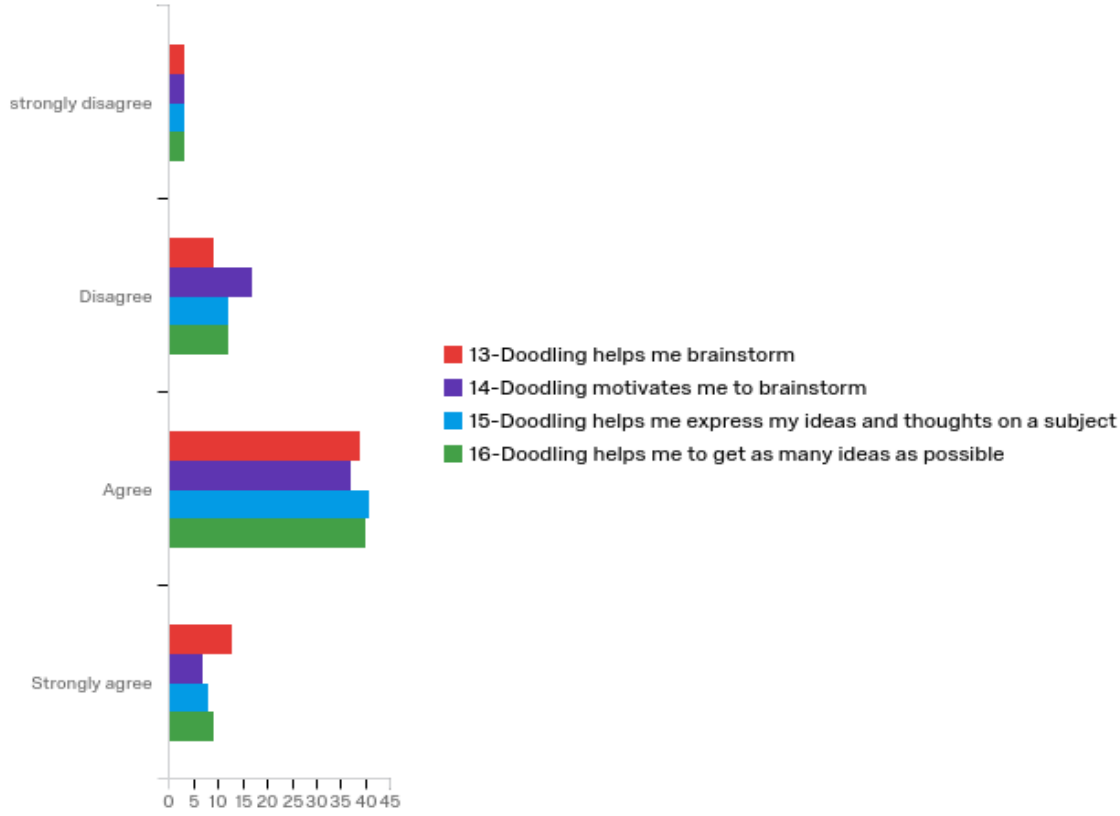

Figure 11. Graph of brainstorming factor.

Involving enjoyment in any learning process increases the level of achieving desired learning goals. Many studies supported the idea that significant learning occurs when students enjoy it (Goetz, Hall, Frenzel, & Pekrun, 2005; Shernoff, Csikszentmihalyi, Schneider, & Shernoff, 2003). Even though enjoyment was not a part of the cognitive factors I was measuring, I asked participants to assess whether or not doodling was an enjoyable learning tool. A strong percentage (an average of 75%) indicated a majority of students either agreed or strongly agreed with questions 17-20, stating they enjoyed doodling while learning (see Table 9 and Figure 12).

Table 9

Frequencies for Enjoyment Factor

Question	Strongly Disagree	*N*	Disagree	*N*	Agree	*N*	Strongly Agree	N	Total
17--Doodling helps me enjoy the class time *M* = 2.86 *SD* = .687	3.13%	2	21.88%	14	60.94%	39	14.06%	9	64
18--Doodling is easy because everyone can do it *M* = 2.98 *SD* = .787	6.25%	4	12.50%	8	57.81%	37	23.44%	15	64
19--Is the use of the doodling fun for you? *M* = 2.97 *SD* = .689	3.13%	2	15.63%	10	62.50%	40	18.75%	12	64
20--Doodling encourages me to learn *M* = 2.55 *SD* = .834	10.94%	7	34.38%	22	43.75%	28	10.94%	7	64

Note. Figures might not add to 100% due to rounding.

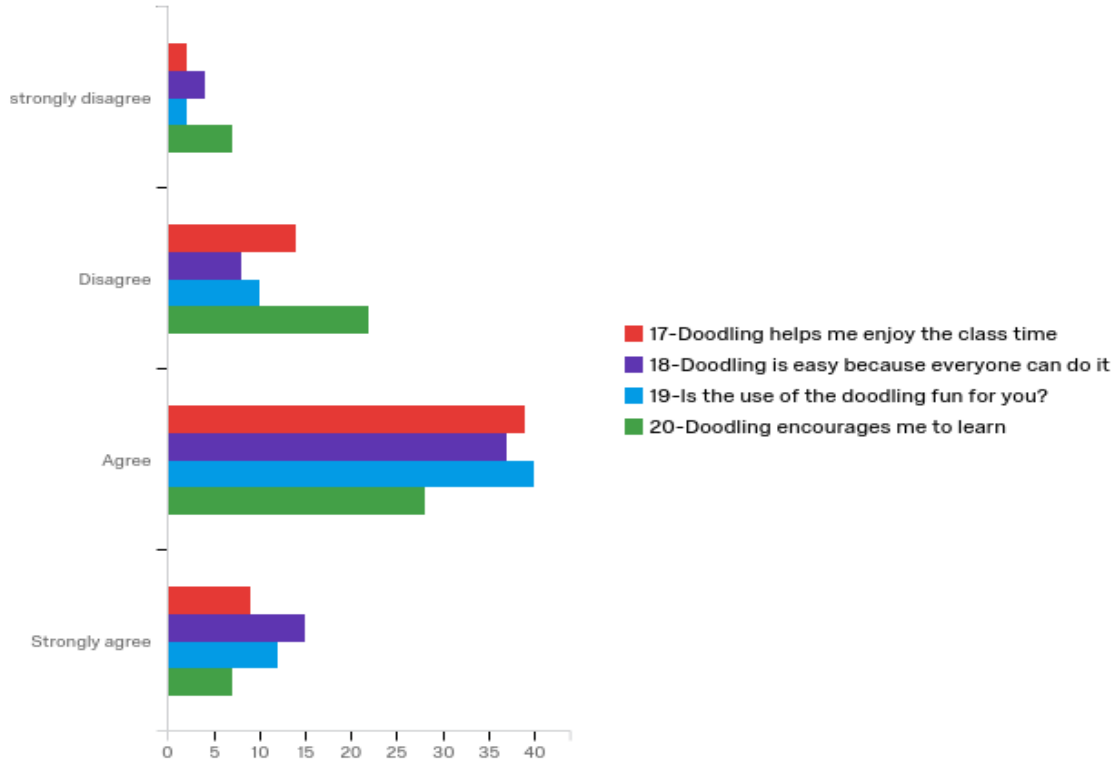

Figure 12. Graph of enjoyment factor.

The final subsection of research question two asked the following:

Q2d Is there a difference in the use of meaningful doodling between recalling content knowledge, student brainstorming, visualization, and understanding of complex concepts?

A one-way ANOVA was conducted by using SPSS on the responses to this question (see Table 10). No significant differences were found between those four factors, $F(3,252) = 2.502$, $p = .060$.

Table 10

Analysis of Variance of Using Meaningful Doodling

	Sum of Squares	df	Mean Square	*F*	Sig.
Between Groups	43.906	3	14.635	2.502	.060
Within Groups	1473.844	252	5.849		
Total	1517.750	255			

Qualitative Findings

The following research questions were used to guide this study from teachers' perspectives:

Q1b What are teacher perspectives about the student use of doodling in the learning process?

Q2 How does doodling contribute to the development of students' cognitive processes?

The interview questions were related specifically to the five factors mentioned at the beginning of this chapter: ability to visualize thinking, memorization or recall, complex ideas, brainstorming, and enjoyment. Those questions assessed teachers'

perspectives about whether doodling had influence on those factors in the learning environment. The findings presented here are separated into the following themes regarding the research questions: the learning process, cognitive understanding, content-based complex concept, and other benefits.

The Learning Process

A**bility to visualize thinking.** Mary spoke about the learning process throughout the interview. She used doodling in the classroom as a way to help students think visually. She mentioned that when information was invisible, doodling could make it visible. "For example," she said, "[doodling is] something like the layers of an art project" where the students learn about how each layer of a painting is part of a larger process. She added, "They're making meaning about language visually."

Likewise, Judy mentioned in her interview that doodling and visualization are two related concepts enhancing the learning process because they help students visualize the concept. This visualization is important in improving student learning performance and understanding and for grabbing students' attention. Judy stated, "It really allows me to focus in on the visualizing, like what's happening in their head, and remind them that that's really important." Judy mentioned she used doodling for her reading class; while she was reading the story, she asked them to imagine the story in their head. She explained that in this way, the students were really paying attention because they wanted to imagine the story so they could doodle it later. Doodling helped them model what they read. Judy was also a participant in their doodling--she doodled with them so they could enjoy their time together. What she did to grab their attention was to make the doodling

funny in such a way as to make it like a joke and this really helped them pay attention. Judy explained:

> What we'll do is, we'll read the stories, and then I'll go back and read a paragraph, and then I'll ask the students, "What are you imagining in your head? What picture do you have in your head." And usually, I'll start by modeling it for them. I'm imagining this when I read this. And then I'll go ahead and doodle on the board.

When talking about how doodling helped in the learning process, Judy also said, "They get to synthesize and put it on their doodle what they are learning, and then they have these notes that they can go back to whenever they want, and it really helps them focus and concentrate." She added, "It helps put them with their senses" by which she meant students were using more of their senses by doodling and they were paying more attention to what they were learning. Veronica also assured me that doodling was a way to help students visualize their thinking using a "different way to express [themselves]."

Focus on the topic and think through the steps. Mary mentioned doodling helped her students stay focused. Doodling is considered a worry-free zone; where there is time during class, students who feel tension during a class subject are able to doodle to relieve stress and have another activity in addition to hearing the teacher lecture. The students are doing something fun and at the same time, they are learning since they are relating their doodles to what they have learned in the classroom. This also helps them focus. Students are better able to think through the steps while they are doodling, which helps them concentrate. Mary stated, "I really think you can actually help them to think through the steps of a project or process prior to physically doing them and anticipate errors."

Veronica expressed her understanding about doodling and learning by explaining that doodling was a way to look at things differently as well as to think differently and more deeply: “I think you start looking at things around you differently, first of all. So I think it makes people a little more observant.”

Cognitive Development

Recalling information and memorization. Mary mentioned that doodling is a powerful tool for recalling information; memorizing images is much easier than remembering the whole text. She mentioned that doodling was “creating a realm for you to actually just recall up in your mind and sort of project, so doodling is like a projector of the brain at the front of your head.” This could be especially true for students with disabilities. For example, if a student has a definition but can only come up with two or three words of it and it still does not make sense, and because of their disabilities it is hard for them to understand and remember smoothly, then she lets them doodle so they can convert the meaning of the word into a visual context that helps them understand and remember the definition.

Judy agreed with Mary that doodling could have a great impact on remembering and recalling information. She explained doodling could help students with retention; instead of reading the entire text again, they could turn back to their doodle and try to recall what they learned. In this way, they are also saving time even if they are going over the same material more than once. Judy specified, “If they have a doodle on the paper, instead of having to try to read that whole text again, they can look at their doodle and the recall is much more efficient and faster.” In addition, Judy added doodling helps

improve comprehension. She explained, “By forcing them to imagine something in their head, it instantly helps facilitate their comprehension and improve their comprehension.”

Veronica stated:

> Instead of just throwing information out constantly for 90 minutes, you've got built-in stopping points, which is good for your brain and for retention, but also gives me a quick formative assessment. So I can just walk around, and I can see what they're doing.

She confirmed the idea that doodling decreases the cognitive load and gives students a break during class; it is not a regular break--it is a learning fun break. Veronica also used doodling to add new concepts for the benefit of a class when it was time for her to conduct formative assessment. If the doodles did not represent what they were supposed to, it meant the students did not understand the concept so she would go over the lesson again. Veronica explained this “is a way to access that background knowledge.” She mentioned recall and memorization: “I give them two minutes. Just represent this concept with a sketch. And within those two minutes, I can walk around. And I can see all right, did they get the gist of it? If not, then I know I need to go back and re-teach that.”

Brainstorming and mind mapping. When I asked about brainstorming, Mary talked about how doodling made students let go. She clarified that by explaining how doodling made students examine things more deeply; then they could scaffold and construct what they learned. In this way, students build a mind map, she explained. She continued the explanation by saying:

> They’re not judging themselves as they’re drawing. They’re literally just letting go, and the pattern becomes an extension of their mind. It really focuses them on a certain topic, and then they have a mind map of that that they can go back to later on the test and visualize each one of those pieces.

When Judy talked about brainstorming, she said her students "call it a brain dump. Dump everything that you know into a big sketch note." Judy was assured that doodling could help in brainstorming. She called it "the power of the pencil." She also explained that students "become comfortable with the process…the more that they find that it's an effective way to brainstorm things or come up with ideas."

Veronica thought doodling is a perfect tool for brainstorming, especially if she used it in a group setting where students thought together; they had more ideas and added details to their doodling: "If they're brainstorming, they can do it individually for two minutes on a topic. And then get together in a small group and see what's the same, what's different. And then create a larger sketch based on the individual sketches, and add details."

Linking ideas together. Mary mentioned doodling is really helpful in connecting the way the students think. Doodling helped ideas they learned in the classroom be more linked together, which helped with cognitive development in general. Therefore, if there was a hard concept they should learn, she let them doodle to make connections and link those concepts together. Mary firmly stated that "doodling is not disconnecting." She was sure doodling was not simply a mindless activity students do when they are bored:

> If there is a concept that needs a lot of time to understand verbally, when you let the student doodle the idea or concept on a piece of paper and let them connect and link it in their way [it can] clarify the concept and make it easier to understand.

Judy viewed linking concepts together as more of a visualization process. She mentioned doodling could help students in the classroom when they doodle new information. At that point, "they connect that information with an image," she stated. Judy considered doodling a tool to transfer the reading or what they learned in the

classroom to the image they created. Veronica also expressed the idea of how doodling linked ideas together: “I think it just heightens their awareness. That's the biggest thing” and (from the students’ point of view), “My gosh, I'm really thinking when I'm doing this. I'm trying to think of connections. I'm trying to put it together.”

Content-Based Complex Concepts

Problem solving. Mary stated doodling gives students some freedom and space, which helps their creativity and with thinking outside of the box. She suggested this leads to better problem solving and could generate more ideas. She stated:

> There’s a freedom there that they don’t have when they’re doing other types of drawing. And secondly, it’s a proactive way of problem solving. So, they can sort of anticipate what might be coming. So, there’s a level of anticipation there when you’re working through something visually that might not be there in other ways.

Judy talked about how doodling helped students understand complexity. “It'll help everything improve,” she said. “I think it changes everything.” She mentioned some concepts were challenging for students and they needed some tools to lead and assist them with the concepts. From her perspective, doodling is a powerful guide for challenging concepts. Doodling can help facilitate complex concepts because the learner needs to really think through the steps. This helps students recognize many concepts by focusing recall and retention. Judy thought doodling improved comprehension, which reflected positivity in understanding complicated concepts. She put it this way: “Having to take complex information that you're hearing and think about what it means to you and connect it with words and visuals and then draw, it automatically improves the comprehension of a concept.”

Veronica stated, “My goal is to get them to not need me. I want them go to other classes and take those kinds of notes because they think it helps them.” She thought doodling was a beneficial way for students to grasp concepts and she wants her students to use doodling in other classes. She knew it worked but was not sure how exactly it worked. This was the reason behind her participation in the study--she wanted to know how doodling helped students grasp concepts. Veronica said, “I don't have any hard data. That's on my list; that’s what I want to know.”

Breaking down concepts. Mary cited processing information was not easy for many of her students to digest. In her situation, this was especially true because she was working with many students with special needs. Mary thought breaking down each concept or idea helped to ease hard or complicated concepts: “If they can draw all those separate processes out individually, they can break something down into a much more digestible thing.”.

Judy mentioned doodling helped in breaking down concepts students learned in the classroom. This was especially true for learning new or complicated concepts. She said, “Drawing just breaks up things, it gives you a chance to take a break and shift your brain.” “Being able to clarify” was how Veronica confirmed the idea of how doodling was used as a tool that helped with complex concepts: “You're really thinking. You're sifting through and prioritizing which ideas make the most sense for that [concept].”

Color coding. Mary clarified the use of color in students’ doodling helped a great deal for visualizing complex concepts. She explained using color coding while students doodle was really powerful:

> I also think color coding is big. I really encourage a lot of my kids who I see do well with the doodling and benefit from the doodling to color code things, but

> when they're going back into notes for other classes, I remind them, color is a powerful thing, and you can use color to help you. For me, that was essential in note taking.

Other Benefits

Enjoyment. Mary stated, "Doodling will not hurt." This quote helped to explain that if students did not like doodling or thought it was not working for them, it did not make their learning any worse but it was not as powerful. She thought doodling was a simple way to help with the learning process. It does not have any complicated side effects on students. She thought it helped because most of her students enjoyed it. Judy mentioned that adding humor to the doodling made it more enjoyable and redeemable: "I add my own little humor in my doodle. And I think even just adding that kind of humor into things lightens up things." In addition, Veronica mentioned, "The worse my drawings are, the more likely the kids are ready to come up and say, 'Hey, now, I can do better than that.' And they'll come up to the board. So it's playful, and fun."

Calming tool. Since Mary works with students with special needs, she found some of the students were more active. This meant they had trouble staying still for long periods of time. When this happened, she said it was time for doodling because they needed to do something else instead of just sitting on the chair and listening to the teacher:

> I've noticed [the effect of doodling] most in my students with learning disabilities and my students with ADHD. I feel like it's made the biggest difference for them, because I see it, one, calming them. Being able to do something with their hands for my ADHD students is huge.

Doodling helped students settle down and made them calm because there was no worry while they were doodling; there was no judgment and there was no right or wrong. Whatever students drew or doodled was acceptable because the image was specifically

for that student. It was understandable for that student and did not need to be understood by other students. This activity helped students get back to normal and stay focused. Mary considered doodling to be a worry-free zone. Whenever there was time during class and the students needed to relieve stress, doodling was useful. At the same time, they are learning since they were relating doodling to what they had been learning in the classroom. "I've also noticed for many of my more hyperactive students that doodling actually basically calms their body," Mary explained.

Judy also found doodling helped calm students. She looked at how the process seemed to work on the students physically as well as mentally. She stated doodling "has this kind of instant calming. …doodling must affect the endorphins in your body, because it just leads to calm." Veronica added, "It's a change of pace. I think it gives them a little bit of time to absorb what they're learning." She thought that between learning each concept, they needed a peaceful time where they could think through what they learned and gain knowledge from their perspectives.

Since this study was an explanatory design, Veronica was asked about the results found from the student responses to the survey questions. Fewer than seven of all the students in this study said they were not comfortable with doodling and felt they were not getting any benefit from the use of doodling in terms of learning. Veronica stated not all students would agree on any one thing. Each student has his or her own preferences; if some of them did not want to try a new experience, "they are quick to come up with excuses." Veronica felt the fact that a few students did not think doodling helped them did not mean she should stop using this method. As a teacher, she felt she always needed

to try new, different things until she found the best way that worked for the most students. She added, “[Disagreement] doesn’t mean we quit trying!”

Students’ Perspectives of Doodling

The second part of the first research question addressed the student’s point of view:

Q1s What are students’ perspectives regarding how doodling helps them learn? To address this question, I used open-ended questions at the end of the survey.

Doodling enhances learning and it is fun. Most of the students stated doodling helped them in learning. Each one of the students described the benefit of using doodling differently. In a few simple words, each student mentioned how doodling helped them in the learning process. For example, one student said, "My doodling (sketch) would be adding pictures to [a] paragraph or sentence…because it would get me an idea what [the concept] is. Also making it colorful, so it can be more alive." A second student agreed, "Yes, it helps me to learn and be creative." When it came to improving learning, a student said the purpose of doodling "is focusing and understanding." Other students had the following short responses to how doodling helped with the learning process: "[Doodling helps me] when there is a class that I can’t understand", "[doodling] helps me pay attention in class,” and another said it “helps me concentrate." One student’s comment was more complete: "For me, doodling is easy because there's always big long information and sketching it makes it easier, since it breaks down information to way easier understanding."

Other students included these short responses of how doodling helped them in terms of comprehension: "It helps me memorize stuff I learn," "I kinda [sic] understand

more rather than the teacher talking," "[Because] when I see it I think about it even more than just writing it down," "By showing what I'm learning," and "Well the drawings help me understand it better because I make pictures in my head that helps me a lot." Two other students added: "When I am using doodling, I only use it for brainstorming my ideas. Drawing it helps me understand more on what's going on in the story or maybe remembering words." "Because I view my notes that I took in class to [study] for next day of class. I will be ready to learn more." These quotes demonstrate how doodling helped learning from students' perspectives on many aspects including helping them understand and linking what they learned to visual representation. Creativity, focusing, and remembering were the main points the students mentioned (see Figure 13).

Figure 13. High frequency words regarding visualization.

The same students responded to whether or not they thought doodling was an enjoyable and fun tool besides being a learning tool (see Figure 14). Some of their responses included the following: "Yes because it tells you [what] the lesson was about and you learn it in your own sketch and you also visualize," "Yep, because it helps me get my mind off things," "[It's] fun because I get to sketch what am learning about and make it easier," "Yes because I'm those type of people who like pictures and adding color," and "Doodling is fun for me because it [is] way better than having to write down words."

Figure 14. High frequency words regarding enjoyment.

Doodling hinders learning and it is not fun. For a minority of students, doodling did not seem to help them (see Figure 15). They thought doodling distracted them and they would engage in it only if they were bored. One student responded to a question as if she were somewhere in between liking and not liking doodling: "It doesn't

help me sometimes because sometime I just start sketching other thing and am not focused." Others agreed with her: “I draw horribly," "It distracts me," and “[I find myself] not paying attention and [it] is difficult to draw."

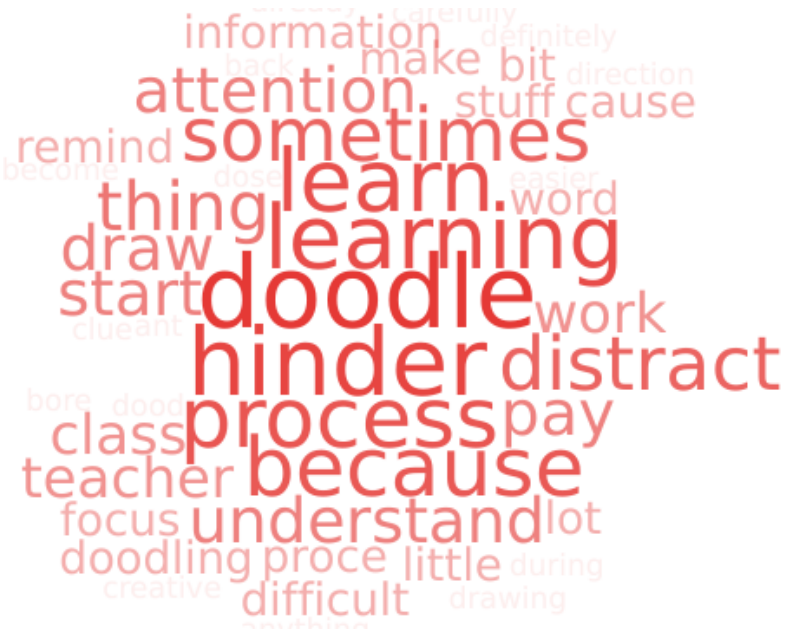

Figure 15. High frequency words regarding doodling being a hindrance.

One student tried to focus with her doodling but suddenly found herself doing something else, which was why she thought doodling hindered her learning process. Another student stated he did not think doodling helped him learn; it was not fun for him because he did not believe he could draw. He was emphatic when he said: “Students need to SEE what I mean....even though I can NOT draw.....at ALLLLLLL (emphasis by the student)." Another student agreed without as much emphasis: "Doodling hinders my learning, because it can be distracting putting too much time on just doodling and not doing other productive things."

Conclusion

Quantitative Summary

For each factor (visualization, recall, complexity, and brainstorming), more students agreed doodling helped with their cognitive development. The one-way ANOVA also showed no significant differences among the four factors, which indicated support for the agreement shown for each factor. These factors were hypothesized because of earlier work I had completed in the field (Zeyab, 2015). However, after a check of the correlations between factors and the factor analysis, the components of each factor seemed to be very related. Also, the factor analysis did not reveal four distinct factors so the factors and questions need to be re-examined to see if a better fit can be found; a three-factor solution might be more appropriate.

Overall, the findings indicated doodling could be a useful tool when used in the classroom. More students and teachers agreed than disagreed about the major categories and factors analyzed. Not only did the findings indicate doodling helped with cognitive development, the findings showed most students found doodling to be fun. This was stated after measuring the fifth factor--enjoyment.

Qualitative Summary

The findings from the interviews demonstrated how important categories were repeated over and over by the participants. Those categories led to significant themes that provided answers to the research questions. In this study, I described five factors mentioned earlier in the previous chapters: enjoyment, memorization, complex ideas, brainstorming, and the ability to visualize thinking. All the themes were included in the participants' explanations and experiences with doodling in learning. Teachers'

responses demonstrated the importance of teaching students how to doodle and how it could be used in the classroom to increase cognitive development. Responses from students to the open-ended questions were mostly favorable to using doodling in the classroom to help them learn and understand complex ideas. Many students also responded favorably to enjoying doodling.

CHAPTER V

DISCUSSION

In this study, I aimed to answer the research questions to show the importance of using doodling as a technique in the classroom and how doodling affected student performance. One group of participants included expert teachers chosen from across the United States who all used the doodling technique as a learning tool with their students because they were assured of the vital use of doodling in the learning process. Other participants who answered both open-ended questions and a survey were students in classes taught by one of the participating teachers. Since few studies have been conducted regarding what teachers believe about doodling and no research was found about doodling from students' perspectives, I conducted this study to explore if doodling would work as an effective learning tool.

Many words showed up in the participants' responses with similar meanings and were convincing for why doodling should be used. Brainstorming, simplifying complex ideas, remembering, and problem solving were all common expressions I found in the interviews. From these expressions, five themes emerged: enjoyment, memorization or recall, complex ideas, brainstorming, and the ability to visualize thinking. Some of these themes were also mentioned in the literature review (Ainsworth et al., 2011; Andrade, 2010; Pfister & Eppler, 2012; Schellenbarger, 2014). Saturation in the participants' answers showed how doodling helped them process information. This discussion

continues by examining each part of the research questions. The first section of this chapter discusses the findings of this mixed method research. It is followed by the implications, limitations, and then recommendations for future research.

Findings According to Research Questions

Q1 What do teachers and students perceive as the affordances and constraints of doodling as part of the learning process in a high school classroom?

Q1a What are students' perspectives regarding how doodling helps them learn? (open-ended questions)

Many of the students discussed how they enjoyed the process of doodling. If students enjoy doodling, they tended to use it more often and it would become more meaningful for them as they used doodling for recall. When students got involved in doodling using colorful markers, drawing, word mapping, and arrows, they seemed to be more satisfied and the doodling reflected how they understood the lessons.

Students also described how doodling helped them think about what they were learning in the classroom by breaking down concepts into small pieces. One student expressed: "This helps increase the ability to think differently." With doodling, they could work systematically to comprehend large amounts of information.

Some students believed they did not benefit from doodling because they did not know how to draw even though the teacher explained drawing ability was not as important as the act of visualizing the concepts and ideas. The teachers continued to encourage students to doodle so the students learned it was not the form of the drawing that helped them learn and recall. What was important was the process of doodling while listening and thinking. Students were at times perceptive about how well they learned by using doodling. They seemed to realize doodling was part of the learning process.

Q1b What are teacher perspectives about the student use of doodling in the learning process? (Interview questions)

This study supported findings from previous studies that integrating visualization in the learning process might affect students' performance in understanding (McKay, 1999; Mayer, 2009; Stokes, 2002). All the participants agreed doodling was a tool that could be used in any learning process. The three teachers who participated in this study had an average of 10 years' experience. From the interviews, I found all of them integrated doodling with students because they had seen how effective it was when they tried it as a teaching tool. They added doodling as a technique in the classroom and encouraged students to use it in different subjects such as reading, math, and science.

The findings here also confirmed findings discussed in the literature review that imagining while hearing the lecture in the classroom and reflecting this on a piece of paper would lead the student to visual thinking (Rasul et al., 2011; Yunus et al., 2013). All of the participants agreed doodling facilitated students' ability to visualize their thinking while hearing the lecture in the classroom. One interviewee reported most of the students enjoyed the process although usually some were reluctant. Another interviewee reported all of the students seemed to enjoy the process, especially when she added humor to her own drawings.

Doodling was used to express what students did learn. Adding this visual process could lead students to focusing and making them think through the steps while they doodled because they tried to imagine what they heard and reflected this thought by doodling on a piece of paper. This also agreed with previous findings (Aellig et al., 2009).

Q2 How does doodling contribute to the development of students' cognitive processes?

This question was designed to measure if there was either a positive or negative effect on student cognitive processes. Previous researchers asked if meaningful visuals could be a significant tool for decreasing cognitive load (Cook, 2006; Lohr, 2008; Mayer, 2003). In this study, I measured the cognitive process using four different themes (visualization, recalling information, complex idea, and brainstorming) I developed from a previous qualitative study about the experiences of participants who engaged in visual thinking through doodling (Zeyab, 2015).

Descriptive analysis was conducted for all four factors to show the mean and the standard deviation. The means for four factors fell between 2.86 and 2.08 so each mean was closer to agree than disagree on a 4-point Likert scale. This indicated doodling could be a significant technique to use in the learning process. This result confirmed other study results about how to integrate visualization in the learning process to positively affect student learning and performance (McKay, 1999; Mayer, 2009; Stokes, 2002). Doodling could be reflective of the cognitive process in general as confirmed by Brown (2014). In the following sections, I discuss the results of each factor from the highest to the lowest means.

Brainstorming

The mean for the brainstorming factor was 2.86, which means most of the students agreed doodling was a good technique that could be used for brainstorming. This confirmed previous research (Pfister & Eppler, 2012) about using doodling as a tool for brainstorming ideas. One interviewee said doodling helped clarify the brainstorming process "because it makes those ideas very, very clear." Two of the teacher participants

suggested doodling while brainstorming in groups was a “great unifier” and helped students come up with ideas together.

Recall

The mean for the recall factor was 2.80; 74% of the students mentioned how doodling could be helpful in recalling and memorization. This indicated doodling could be an active part in the learning process, leading students to recall information better. This result confirmed previous findings that doodling was related to recalling (Ainsworth et al., 2011; Andrade, 2010; Schellenbarger, 2014). Using doodling as a way to help with recalling information is one more aspect upon which all three teacher interviewees agreed. One teacher interviewee reported it helped students create a “mind map” they could tap into and recall important information.

Visualization

The visualization factor showed a mean of 2.65; 59% of students agreed doodling led to visual thinking. Doodling allowed students to not only visualize what they were thinking, it helped them present their ideas visually. The idea of using doodling for visualization was found in previous studies about doodling and learning (Brooks, 2009; King, 2011; Steffani & Selvester, 2009). All three teacher participants agreed doodling was a helpful tool for visualization. As one said, students are “taking what we're seeing and what we're hearing and we're connecting words to images.”

Complexity

Not much difference was found between the visualization factor and the complexity factor as the mean for complexity was 2.63 with 57% of the students agreeing doodling could be a useful tool for facilitating understanding of complex ideas. Doodling

is considered a way to break down concepts and help with abstract ideas. This was one aspects teachers found useful for their students--being able to break complex concepts into pieces so students could understand easier if they drew each piece of the concept. Then, as the students put the doodles together, they would begin to see the larger picture of the concept. One teacher stated, "When you have to sketch an abstract concept, you're really thinking. You're sifting through and prioritizing which ideas make the most sense for that." This factor was also supported in findings from previous literature where some researchers mentioned how integrating visualizing and drawing could lead to better understanding and focusing (McKay, 1999; Mayer, 2009; Stokes, 2002).

From the teacher interviews, I found the participants' responses supported two prior studies that discussed the concept of doodling helping in the recall of information (Ainsworth et al., 2011; Andrade, 2010). All of the participants agreed doodling was important for improving cognitive understanding. They all stated doodling had a significant effect on students and helped them to memorize and then recall information. The participants mentioned this kind of process was like breaking the routine and thinking outside of the box, which led to remembering the information easier and faster. The participants stated doodling helped link the visual with words; they felt this linking was important for recalling and memorization. The participants agreed doodling helped in brainstorming and mind mapping; they also felt the use of doodling helped in clarifying complex ideas. From all of these statements by the teachers, it can be concluded that the integration of the doodling technique in the learning process seemed to make an important difference in enhancing the cognitive development of students involved in this practice.

Q2d Is there a difference in the use of meaningful doodling between recalling content knowledge, student brainstorming, visualization, and understanding of complex concepts?

This research question addressed if doodling affected one or more factors differently than any other. I wanted to find if there was a significant difference among the factors. For this study, I ran a one-way ANOVA for the four factors; the results showed no significant difference among them. This result might indicate meaningful doodling had nearly an equal impact on each factor; however, the survey needs to be refined before the results can be completely understood. The descriptive statistics indicated all of the factors had an effect on the development of cognitive understanding. The teachers all agreed using meaningful doodling helped with all of the factors but they did not stress whether doodling was more important for any one factor. This suggested meaningful doodling was helpful for recalling information, brainstorming, visualization, and understanding complex concepts. More research would need to be done to determine if significant differences exist among any of these effects.

What Should Be Considered About Meaningful Doodling: Researcher Voice

Attention! This research might change some teachers' opinions about still holding onto the old way of teaching where students should be watching the teacher while she/he is lecturing and doodling is forbidden. This might even influence some student to steal a moment to doodle on the desk!

This study turned attention toward a new technique that is easy for everyone to use and practice and where there is no judgment or no rules apply. It is the power of paper and pencil. It is the revolution of meaningful doodling. As mentioned earlier in previous chapters, it is hard for students to process huge amounts of information they are

covering every day, especially without clues that help to increase their cognitive development, which then leads to many other things like recalling, remembering, and problem solving.

The importance of this study was to find if doodling worked or not. Since it is a new topic, my job was to dig more deeply into this topic, find teachers who applied this tool in their learning processes, and to find students who already practiced this technique for a period of time. Results from this mixed method study showed a positive side of doodling. It not only would not hurt but it was also a beneficial, effective tool that could be used in the classroom for a variety of subjects and ages. Doodling could lead to better understanding of learning concepts and develop cognitive understanding. This study will guide other studies and turn us toward more research about how effective doodling could be in learning and how using it seriously could help with focusing on various topics. The power of doodling could be even more advanced if teachers implemented creativity in using color in students' doodling to easily track important information. If teachers love iPad products, they could take their doodle and turn it to a fun, enjoyable learning tool. So there is no right or wrong, no rules, and no judgment. Doodling is a free zone--so just keep calm and start doodling.

Is Meaningful Doodling Good for Everyone?

The purpose of my study was to learn about the effect doodling could make on learning. Others interested in studying this topic should realize there are still many questions. My role as researcher here was to dig deeply and focus the lens on the doodling technique from different angles. The major question was whether doodling could be used as an effective learning technique in the classroom? Only a few studies

have been conducted in this area (Aellig et al., 2009; Andrade, 2010). Another study shows doodling did not help in recalling information but the small sample of only 14 participants were separated into two groups of "doodling and not doodling." The results indicated the participants did not use doodling to help with recall (Chan, 2012).

In my study, a small number of participants did not seem to like doodling but this is normal when applied to how people approach a new concept--not only in teaching and learning techniques but in life. Differences exist everywhere related to individuals and learning styles. As mentioned earlier in my literature review, there is no one way a teacher can use doodling in teaching that involves all types of learning styles. The role of the teacher is to try to maximize the number of people who benefit from any teaching situation by trying to involve everyone (Felder & Silverman, 1988; Hunt, 1972; Stokes, 2002). Not all students can agree on one thing, especially if it is newly integrated into the curriculum. Also, many other reasons could affect any learning situation.

In the results of my study, I noticed that a few number of students agreed on how doodling may not be effective on learning. "I draw horribly" and "It distracts me" were two of the most common responses for that group of respondents. Most of the answers on the open-ended questions about disliking doodling was because either they did not like to draw or they felt it was a distracting tool more than a focusing tool. It is possible that, for these few students, doodling is a technique that may not be effective.

However, the majority of students liked doodling in learning. Since this was an explanatory, sequential design, I asked two of the teachers why they thought those students did not like the doodling technique. Each teacher answered differently. One of them mentioned since she taught high school, students this age sometimes do not know

what they want and some students do not want to try to make an effort to understand this technique. She said, “They are quick to come up with excuses.” I suggested high school students are starting to establish their personalities and without even trying, they think something new will not work. They can build negative images in their minds before they even try the new technique. On the other hand, this teacher mentioned that when she used to teach elementary school and applied this technique with those students, she only found only one student who did not like doodling. The age of the student might be one factor that affects liking or disliking doodling.

When I asked the other teacher this question, she replied, “That’s why I’m here.” She said she thought doodling is an important tool for the learning process so she teaches it to her students. What she does not know is how it works. She mentioned even if it does not help all of the students, she still uses it since it helps the majority. She said that it is okay if some people think doodling is not needed but we need to keep trying until we maximize the use of doodling to the biggest number of students. “We emphasize trying, and we emphasize that this is one strategy,” she stated.

Implications and Limitations to Doodling

Between considering doodling a tool for distracting and focusing, saving time or wasting time, and offering a method for meaningful visual representation or spontaneous meaningless scribbling, there are still many ways of considering the impact of doodling. This study offered a first impression. If we want to proceed from this point to sort the advantages and limitations of doodling, further research would need to take into account every advantage or limitation such as the person’s age, personality, level of education,

ways of thinking, intended educational purpose and surrounding circumstances, and other factors.

Implications

Research into the effects of doodling, and especially purposeful doodling, is limited because this is a new field of study for educational technology. More research is needed to uncover other missing pieces of the puzzle to create a clearer image to help us understand the concept of integrating doodling. Further research could help clarify when, where, and how doodling might best be used. We could also learn more about how the technique could be used for greater student satisfaction as well as learning.

Limitations

The first limitation in this study was the technique of doodling has not been practiced in many schools so it was difficult to find participants. Having only three participants for the qualitative research component decreased the ability to transfer the results of the study. Another limitation was the students I used for my survey were students who were from the same school and teacher so I did not have the variety of student participants I had wished. I did not run a pilot study because the number of participants was limited and because not many students were using doodling in learning, which caused another limitation because the survey I used was not standardized. This meant when I ran a factor analysis using SPSS, it showed only three factors even though the survey had four theoretical factors. The survey needs to be improved and more participants are needed to increase the validity. However, as reported earlier, since this is a new area of research, no surveys were found to measure this concept so this would be a

first step in this research. This research is not the end--it is just the start for future research.

Recommendations for Future Research

Since there is a gap in the number of studies in this area, many opportunities are available for future researchers to be involved. Many studies could be conducted from different perspectives to evaluate doodling as a learning technique. Replication of this study with different ages of participant would be useful to see if any differences could be found in the results. Another focus for future studies would involve the use of qualitative research to further explore the significance of doodling from the teacher's lens. This area could focus on teachers' attitudes toward using doodling in the learning process. Another research avenue would be to find out how teachers could help students add drawing or purposeful doodling as a strategy for learning with traditional reading and writing. Also, pre-and-post surveys for students who were taught to learn specific subjects using the practice of doodling could provide stronger evidence of the impact doodling might have on student learning.

Conclusion

Doodling doesn't mean discounting. (Hoeve, 2016)

After conducting this study, the other meaning of doodling was clearer. What I mean by this is doodling has two faces right now: the everyday doodling people use just for fun but is not guided to lead them in specific paths versus academic or purposeful doodling where doodling has more focus, is related to content, and is utilized as a way to help to understand and visualize key ideas.

Through this study, I determined that people could believe in and use the purposeful side of doodling for academic purposes. Using purposeful doodling is powerful; the bright side is my participants believed doodling helped the learner to achieve a higher level of remembering or recalling information and to visualize concepts. Finding a new approach to thinking and learning requires learners to try new strategies instead of sticking with the traditional ways of thinking. At the same time, teachers can help students learn to use doodling with more purpose to encourage deeper learning. Trying to doodle is one way to discover what is suitable and more comfortable for each individual, especially if the learner is not confident in drawing.

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APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL

UNIVERSITY OF
NORTHERN COLORADO

Institutional Review Board

DATE:	October 12, 2016
TO:	Alaa Zeyab, Master
FROM:	University of Northern Colorado (UNCO) IRB
PROJECT TITLE:	[944379-2] Education Technology and Visual Literacy: The Effect Of Using Doodling On Student Learning Performance
SUBMISSION TYPE:	Amendment/Modification
ACTION:	APPROVED
APPROVAL DATE:	October 12, 2016
EXPIRATION DATE:	October 12, 2017
REVIEW TYPE:	Expedited Review

Thank you for your submission of Amendment/Modification materials for this project. The University of Northern Colorado (UNCO) IRB has APPROVED your submission. All research must be conducted in accordance with this approved submission.

This submission has received Expedited Review based on applicable federal regulations.

Please remember that informed consent is a process beginning with a description of the project and insurance of participant understanding. Informed consent must continue throughout the project via a dialogue between the researcher and research participant. Federal regulations require that each participant receives a copy of the consent document.

Please note that any revision to previously approved materials must be approved by this committee prior to initiation. Please use the appropriate revision forms for this procedure.

All UNANTICIPATED PROBLEMS involving risks to subjects or others and SERIOUS and UNEXPECTED adverse events must be reported promptly to this office.

All NON-COMPLIANCE issues or COMPLAINTS regarding this project must be reported promptly to this office.

Based on the risks, this project requires continuing review by this committee on an annual basis. Please use the appropriate forms for this procedure. Your documentation for continuing review must be received with sufficient time for review and continued approval before the expiration date of October 12, 2017.

Please note that all research records must be retained for a minimum of three years after the completion of the project.

If you have any questions, please contact Sherry May at 970-351-1910 or Sherry.May@unco.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within University of Northern Colorado (UNCO) IRB's records.

APPENDIX B

TEACHER PARTICIPANT CONSENT FORM

CONSENT FORM FOR HUMAN PARTICIPANTS IN RESEARCH
UNIVERSITY OF NORTHERN COLORADO

Project Title: Education Technology and Visual Literacy: The Effect Of Using Doodling On Student Learning Performance
Researcher: Alaa Zeyab, Department of Education Technology
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Faculty Advisor: Mia Williams, Department of Education Technology
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You are invited to participate in a study about doodling. The purpose of the study is to analyze the perspectives of teachers and students who engage in the visual thinking through doodling. Since this is a mixed methods research, a separate method of data collection will be used to represent each methodology; I will use a survey for students to answer the quantitative research questions and interviews for teachers to answer the qualitative research questions. This consent form is for teachers.

Your interview will be conducted either face to face or supported by technology as agreed upon by you and myself as the researcher. The interview will take approximately 30-60 minutes. The interview will consist of three parts. In the first part, I will explain this consent form to you and obtain your verbal and written permission to continue. The second part consists of questions I will ask you about how you and your students use doodling as part of the learning process, and will include information from the student survey. Finally, I will ask you some optional basic demographic questions in the form of your race/ethnicity, age, gender, and teaching experience.

There is no foreseeable risk to being involved in this study. The level of discomfort you may experience is not beyond that of discussing the topic of doodling with other colleagues you may encounter on a daily basis.

You will not provide your name, but will be asked to provide the demographic information listed above. All of your responses will be kept confidential. Only the researcher will look at the responses. Results of the study will be presented in the research and all original paperwork will be kept in locked cabinets on campus. Audio recordings and signed consent forms will be erased three years after the study. Benefits include my analysis of your use of doodling as a learning technique from both your and

your students' perspectives, and an opportunity to enhance the learning benefits of doodling using the results of this study.

Participation is voluntary. You may decide not to participate in this study and if you begin participation you may still decide to stop and withdraw at any time. Your decision will be respected and will not result in loss of benefits to which you are otherwise entitled. Having read the above and having had an opportunity to ask any questions, please sign below if you would like to participate in this research. A copy of this form will be given to you to retain for future reference. If you have any concerns about your selection or treatment as a research participant, please contact Sherry May, IRB Administrator, Office of Sponsored Programs, 25 Kepner Hall, University of Northern Colorado Greeley, CO 80639; 970-351-1910

_____

Participant's Signature Date

_____

Researcher's Signature Date

APPENDIX C

PARENTAL CONSENT FORM FOR PARTICIPATION IN HUMAN RESEARCH

Parental Consent Form

UNIVERSITY OF
NORTHERN COLORADO

CONSENT FORM FOR HUMAN PARTICIPANTS IN RESEARCH
UNIVERSITY OF NORTHERN COLORADO

Project Title: Education Technology and Visual Literacy: The Effect Of Using Doodling On Student Learning Performance
Researcher: Alaa Zeyab, Department of Education Technology
Phone Number: (970) 534-9208
E-mail: zeyab3709@bears.unco.edu

Faculty Advisor: Mia Williams, Department of Education Technology
Phone Number: (602) 677-7199
E-mail: mia.williams@unco.edu

Dear parent, I am researching a type of visual learning known as doodling to see how teachers and students use doodling to help increase students' visual thinking. If you grant permission and if your child indicates to us a willingness to participate, I will use an online survey during class for students to answer questions about visual learning and thinking.

This survey will take about 15 minutes to complete and involves activities that are part of a normal classroom experience. It asks about activities that may occur in the classroom. One example is a survey question that says, "Doodling helps me remember things better." If you agree with that statement, you may answer (I strongly agree) or (I agree). If you do not agree with that statement, you may answer (I disagree) or (I strongly disagree).

If your child agrees to be in this study, I do not foresee any risks beyond those normally encountered when someone talks to your child about any classroom activity. Your child will not be asked provide a name, but will be asked to provide optional demographic information such as race and gender. All of your child's responses will be kept confidential. My adviser and I will be able to look at the responses. Results of the study will be presented in the research and all original paperwork will be kept in locked cabinets on campus. Audio recordings and signed consent forms will be erased three years after the study. If any student or parent chooses not to participate, the teacher will provide an alternative assignment to complete while other students participate in the research project.

Benefits will include entry in a drawing for a $10 gift certificate in addition to my analysis of your child's use of doodling as a learning technique from both teachers' and students' perspectives, and will give your child's school an opportunity to enhance the learning benefits of doodling using the results of this study.

Please feel free to phone me if you have any questions or concerns about this research and please retain one copy of this letter for your records.

Thank you for assisting me with my research.

Sincerely,

Alaa Zeyab

Participation is voluntary. You may decide not to allow your child to participate in this study and if (s)he begins participation you may still decide to stop and withdraw at any time. Your decision will be respected and will not result in loss of benefits to which you are otherwise entitled. Having read the above and having had an opportunity to ask any questions, please sign below if you would like to participate in this research. A copy of this form will be given to you to retain for future reference. If you have any concerns about your selection or treatment as a research participant, please contact Sherry May, IRB Administrator, Office of Sponsored Programs, 25 Kepner Hall, University of Northern Colorado Greeley, CO 80639; 970-351-1910

_____	_____
Child's Full Name (please print)	Child's Birth Date (month/day/year)
_____	_____
Parent/Guardian's Signature	Date
_____	_____
Researcher's Signature	Date

APPENDIX D

ASSENT FORM FOR PARTICIPATION IN HUMAN RESEARCH

UNIVERSITY OF
NORTHERN COLORADO

ASSENT FORM FOR HUMAN PARTICIPANTS IN RESEARCH
UNIVERSITY OF NORTHERN COLORADO

Project Title: Education Technology and Visual Literacy: The Effect Of Using Doodling On Student Learning Performance
Researcher: Alaa Zeyab, Doctoral student, Department of Education Technology
Phone Number: (970) 534-9208 e-mail: zeyab3709@bears.unco.edu

Hello! I would like to ask your help with my research. The purpose of my study is to research the ways teachers and students use kind of visual thinking known as doodling. I am asking you to complete a survey to answer the research questions, while your teacher will be interviewed about the same subject. You will be able to complete the survey process online. Before you participate in the research, though, you must sign this form and your parents must sign a consent form if you are under the age of 18.

This survey is about 15 minutes long and involves activities that are part of a normal classroom experience. It asks about activities that may occur in the classroom. One example is a survey question that says, "Doodling helps me remember things better." If you agree with that statement, you may answer (I strongly agree) or (I agree). If you do not agree with that statement, you may answer (I disagree) or (I strongly disagree).

If you agree to be in this study, it will probably not help or hurt you. Your parents have said it's okay for you to talk with me, but you don't have to. It's up to you. Also, if you say "yes" but then change your mind, you can stop any time you want to. I will not ask for your name, but I will ask you to provide your gender, and age only if you want to give it to me. All of your responses will be confidential. Only I and my adviser will be able to look at the responses. I will not share your answers with anyone, but will group everyone together to share the results of the study. The research and all original paperwork will be kept in locked cabinets on campus. This form and your parents' signed consent forms will be erased three years after the study.

(Please put your initials here)

I do not see any risks to you, but if you feel uncomfortable at any time, you can stop and talk to me or your teacher. I will not ask you to participate in this survey during snack, lunch, or recess times. The questions are fairly simple. There are no right or wrong answers. The only feedback you be given will be positive (e.g., "You answered very well." "You did just fine." etc.). This study is not designed to improve your memory or understanding of others' beliefs but hopefully you will enjoy the activities and the positive attention received. Your name will not appear in any report of this research. If you participate, I will include your name in a drawing for a $10 gift certificate

If you want to be in my research and talk with me about doodling, sign your name below and write today's date next to it. Thank you for helping me with my research!

Sincerely,
Alaa Zayeb

_____	_____
Student's signature	Date
_____	_____
Researcher's signature	Date

APPENDIX E

SURVEY

Demographic questionnaire

Q1 **What is your gender?**

- Male
- Female

Q2 **What is your age?**

- 12-15
- 15-17
- above 17

Q3 **What is your primary language?**

- English
- french
- Spanish
- Arabic
- Other

Q1 **Ability to visualize thinking**

	Strongly disagree	Disagree	Agree	Strongly agree
1- I doodle while I'm listening to the teacher	○	○	○	○
2- From doodling, I learn how to visualize my thinking	○	○	○	○
3- Doodling help me present my idea visually	○	○	○	○
4- I like to draw about a concept when I learn about it	○	○	○	○

Q2 **Ability to memorize/ recall information**

	Strongly disagree	Disagree	Agree	Strongly agree
5 - Doodling helps me remember things better	○	○	○	○
6 - Doodling helps me recall my information later	○	○	○	○
7 - Doodling helps me feel like I'm taking an active part in my learning which helps me recall the concept.	○	○	○	○
8- Doodling helps me to actively process ideas which helps in recalling information better	○	○	○	○

Q3

Complex idea/ understanding

	Strongly disagree	Disagree	Agree	Strongly agree
9- Doodling helps me break down concepts	○	○	○	○
10- Doodling while listening to the teacher helps keep me focused.	○	○	○	○
11- Doodling facilitates the understanding of complex ideas	○	○	○	○
12- Doodling helps me learn abstract concepts easily	○	○	○	○

Q4

Brainstorming

	strongly disagree	Disagree	Agree	Strongly agree
13-Doodling helps me brainstorm	○	○	○	○
14-Doodling motivates me to brainstorm	○	○	○	○
15-Doodling helps me express my ideas and thoughts on a subject	○	○	○	○
16-Doodling helps me to get as many ideas as possible	○	○	○	○

Q1

17- Describe your use of doodling. (open ended)

Q2

18- Is the use of the doodling fun for you if yes describe How (open ended)

Q3

19- How does doodling help your learning process? (open ended)

Q4

20- How does doodling hinder your learning process? (open ended)

APPENDIX F

INTERVIEW QUESTIONS

Interview Questions

1. How do you turn the students' attention to the use of doodling technique in the classroom?

2. How does doodling help you and your students in learning process in the classroom?

3. How has processing information in this visual way improved the learner visual thinking or understanding about concepts?

4. How has processing information in this visual way improved the learner understanding about concepts?

5. Describe your experience with doodling in how this effect on the cognitive development of the student

6. How does the use of doodling in the classroom relate to the recall of content knowledge?

7. How does the use of doodling improve student brainstorming and visual thinking?

8. How does meaningful doodling improve understanding of complex concepts?